Regional Anesthesia

Its Technic and Clinical Application

By

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With a Foreword by

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FOREWORD

REGIONAL anesthesia has come to stay. Its development and progress, for various reasons, have been slow, principally because the anesthetist must have an accurate knowledge of anatomy and a high degree of technical skill in order that the anesthesia may be safe and satisfactory, and the operation not delayed. Heretofore, few surgeons have given the time necessary to master the method of administration, and the details have been carried out by assistants, equally unqualified.

In order to overcome certain inherent defects in regional anesthesia it is necessary in certain cases and desirable in many to use some form of general anesthesia with the regional. In chronic abdominal disease general intraperitoneal exploration is desirable for the purpose of locating and, if possible, removing all lesions at the primary operation. The entire peritoneum is sensitive and in such operations it is impossible to secure, with regional anesthesia, the relaxation and freedom from pain that are essential. A combination of regional anesthesia and a little ether given at the proper time is satisfactory, although in abdominal surgery general ether anesthesia is so satisfactory that most surgeons are content not to use the regional.

The exaggerated claim with regard to the relative advantages of regional anesthesia over ether has been one reason for delay in the general acknowledgment of its great value. For instance, it is said that pulmonary complications are less common following regional anesthesia than following ether. Undoubtedly, this would be true in the presence of exudative bronchitis or any condition causing the accumulation of a quantity of mucus in the upper respiratory tract, but the large majority of pulmonary complications which follow surgical operations are embolic, and apparently as common after regional anesthesia as after general. However, all are agreed that in cases of intestinal

obstruction regional anesthesia in some form is very desirable, because when patients are operated on under any form of general anesthesia their bronchial tubes may fill with regurgitated intestinal secretions, resulting in death from drowning, or later from septic bronchitis due to inhalation of septic material. In cases of acute sepsis regional anesthesia is especially indicated.

Certain patients become nervous and disturbed under regional anesthesia, and it is not always desirable that patients should be cognizant of the operation. Analgesia by the use of sufficient nitrous oxid in connection with regional anesthesia to secure for the patient a comfortable mental attitude has aided greatly in this respect, and in this country has a distinguished advocate.

The expert surgeon who is also expert in the use of regional anesthesia can resect the stomach, the rectum, or any portion of the intestinal tract with ease, and in operations in fixed localities, such as operations for goiter and amputations of all types, he is quite independent of the use of general anesthesia.

The young surgeon should perfect himself in the use of regional anesthesia, which increases in value with the increase in the skill with which it is administered. The well-equipped surgeon must be prepared to use the proper anesthesia, or the proper combination of anesthesias, in the individual case. I do not look forward to the day when regional anesthesia will wholly displace general anesthesia; but undoubtedly it will reach and hold a very high position in surgical practice.

William J. Mayo.

INTRODUCTION

The object of this work is to afford the opportunity of acquiring rapidly a practical knowledge of "regional anesthesia" and to teach the reader how to use the method successfully.

Local infiltration, as practised by many surgeons, is a procedure whose usefulness as a substitute for general narcosis for minor operations is universally admitted; but its possibilities in major surgery are so limited that it is necessary to have recourse to another method with broader horizons. Regional anesthesia fulfils the best conditions hitherto offered for the accomplishment of the most delicate and elaborate surgical procedure.

The injection of an anesthetic solution at random in the structures to be cut through is very easy. It requires neither skill nor experience and can be performed indiscriminately in all parts of the body with equal ease; but the use of adequate anesthetic procedures for the surgical treatment of diseases involving different regions of the body exhibits such characteristic features pertaining to a specialty that the surgeon who attempts to practice regional anesthesia without a fair knowledge of the principles of the method itself is most likely to court failure. It is not sufficient to have watched a few operations performed without the aid of general anesthesia to believe that it is possible for any surgeon to use the method with equal advantage. It is not sufficient to have been present at a few demonstrations in regional anesthesia to believe that it is possible for any man to give it successfully. Experience is absolutely necessary. It can be acquired rapidly by practice, provided one knows what to do and how to do it. This is what the author proposes to teach. Surgeons who do not inject their own patients must not deny the necessity for themselves to be familiar with the method, since the success of the operation greatly depends on their knowledge of the possibilities of the anesthetic procedure employed.

Desirous of facilitating the work of the profession; conscious of the

considerable time lost and energy spent in perusing the literature on the subject; certain of the fruitless attempts to gather promptly and accurately from the three thousand odd publications of the last decade the necessary elements for a good practice, the author has tried to condense in this text the expression of his personal experience of many thousands of cases. The privilege of having injected patients for colleagues who are proficient in the art of regional anesthesia greatly contributed to the author's experience of the manner of handling different categories of patients; that of having induced anesthesia for surgeons who were ignorant of the fundamental principles of the method completed his education as regards the surgical possibilities of the method in different hands. Thanks to all of them. Experience has so far proved that it is possible for a man to inject a patient for another man, provided there is co-operation on both sides.

In setting rules for the guidance of anesthetists, surgeons, and assistants, and laying down instructions for the operating-room nurse, every effort has here been made to discourage all that is considered as detrimental to the method. The absolute necessity for the use of adequate instruments for the accomplishment of the various procedures cannot be too greatly emphasized.

The different segments of the body are studied from the viewpoint of anesthesia. Each technical description is preceded by a short review of the anatomy of the region, with special reference to nerve distribution, in order to refresh the memory of the reader and enable him to understand the different steps of the technic. Historic facts are omitted and theoretic discussions avoided intentionally, but great stress is laid on considerations of higher practical value. Indications are set forth as to the type of operation permissible, but no suggestion is made regarding the choice of operation, which is left entirely to the surgeon's own judgment.

Special chapters are devoted to operations on the eye, ear, nose, throat, teeth, and genito-urinary organs, these departments of surgery being particularly interested in regional anesthesia. The possibilities of field-block, paravertebral block, and splanchnic analgesia in abdominal surgery have been thoroughly established.

Spinal anesthesia forms the subject matter of a separate chapter of this work, because it results from a procedure totally distinct from the rest, although it is considered as an extensive regional anesthesia. The technic of intraspinal novocainization is the only one described, but the attendant circumstances of the method itself are discussed from a practical point of view. Its importance in general surgery is certainly worth the time spent on its study.

The beginner is not expected to be successful with his first attempts to induce regional anesthesia; partial failures can be remedied by the administration of a few whiffs of ether or gas. In fact, many operations in certain cases are best performed with the combined method. But, remembering that even experts are apt to fail, he should try again and again, observing scrupulously the principles of the method, until he succeeds.

The author wishes to express his profound gratitude to Dr. William J. Mayo for his foreword, and to Dr. Charles H. Mayo for the great privilege given him to lecture and demonstrate in the Mayo Foundation, and for the unstinted facilities afforded for the preparation of this book.

To Miss E. Fry, Mr. R. Drake, and other artists of the Mayo Clinic who devoted a good deal of their time to the skilful execution of most of the original drawings, the author's best thanks are due. He is also greatly indebted to Mr. H. Frantz, artist of the University of Paris, for his intelligent aid in completing the beautiful set of drawings which illustrate the whole text.

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To the generosity of the publishers, more particularly to the hearty co-operation of Mr. R. W. Greene, is due the presentation of this most attractive book, which, it is to be hoped, will appeal to the surgeon and specialist, as well as to the general practitioner and medical student.

GASTON LABAT.

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REGIONAL ANESTHESIA

CHAPTER I

METHOD

Definition.—Regional anesthesia is the result of a certain number of delicate surgical procedures by which it is possible to control pain temporarily by interrupting the sensory nerve conductivity of any region of the body. Motor function is occasionally interfered with.

Regional anesthesia is best realized by injecting an anesthetic solution in the immediate vicinity of the nerves supplying the operative field. It is commonly called *local anesthesia;* but it differs from local anesthesia in that the anesthetic fluid is never injected along the line of incision or within the structures of the surgical wound. Local injections, however, are frequently of great help to the regional method which it completes in case of partial failure to block one or more of the nerves supplying the region.

Regional anesthesia may be produced by the use of two different types of procedures:

1. Field-block.
2. Nerve-block.

Field-block consists in creating walls of anesthesia encircling the operative field. The solution is distributed fanwise in certain definite planes of the body, so as to soak all the nerves crossing these planes on their way to the operative area. Sometimes one single wall blocks the desired area.

Nerve-block consists in making extraneural or paraneural injections in close proximity to the nerves whose conductivity it is desired to cut off. When the solution is injected close to the spinal column, at the emergence of the nerve trunks from the intervertebral foramina, it

constitutes "paravertebral block." Blocking the nerve trunks through the posterior sacral foramina is defined as "transsacral block." Injecting the sacral nerves on the anterior aspect of the sacrum is termed "presacral block." Blocking the nerve trunks within the spine, but outside the dura mater, is called "epidural, extradural, or caudal block." Blocking the roots of the nerves within the spine, in the subarachnoid space, constitutes "intraspinal block" by which spinal anesthesia is realized.

Special Knowledge of Anatomy.—A thorough knowledge of descriptive and topographic anatomy, especially with regard to nerve distribution, is beyond discussion. It is a condition which anyone desirous of attempting the study of regional anesthesia should fulfil. The anatomy of the human body must, besides, be approached from an angle hitherto unknown to the medical student and with which the average surgeon is not at all familiar. Nerve blocking must first be practised on the human cadaver, after studying the sites of the body where the nerves seem to be most accessible.

The relationship of those nerves to fixed bony landmarks and to large blood-vessels in their immediate neighborhood should be carefully noted after clean dissections, so as to help visualize these elements through the overlying structures of the body of the patient to be anesthetized. A picture of the whole skeleton, as well as of any part of it, must always be present and printed, so to speak, in the eyes of the operator, so that when palpating landmarks his tactile sense may be led to accurate findings. And this picture can only be obtained by looking frequently at a mounted skeleton from all possible angles and studying it as a whole as well as in every detail; trying to reconstruct the fleshy parts of the body of which it used to be the framework and always endeavoring to see through that imaginary shape the nerves and blood-vessels lying in the exact position they occupied in the living body; comparing one skeleton with another and with several, thus acquiring more experience and printing in the mind a better picture which the eyes may reflect as a standard when looking at any patient.

The skull should be studied with special reference to the labyrinth of foramina, canals and fissures which it presents at its base and the rela-

tion they bear to the surface prominences palpable through the skin. The ways and means of approaching the foramina from every angle by the oral route or through the skin surface is rather tedious; but its study is very fascinating and its knowledge most gratifying. The orbit, its walls, fissures, and foramina should be considered chiefly in connection with the nerve supply of the eye, forehead, nose, frontal, ethmoidal, and sphenoidal sinuses.

Certain irregularities of the skull assume greater importance than others. For instance, the foramen rotundum, the foramen ovale, the sphenomaxillary fossa, the pterygoid process, the zygomatic arch, the occiput, the glabella, the mastoid process should be studied in relation to one another, to the cervical vertebral column, and to the skin surface. The supra-orbital, infra-orbital, and mental foramina should be considered individually, and their respective distances noted from the margin of the orbit and the edges of the mandible, as well as from the midline of the face. Teeth also serve to locate these foramina. The medial aspect of the mandible, more particularly that of the ascending ramus, should call attention with reference to the lingula and inferior dental foramen which is the site of injection of the inferior dental nerve.

In studying the neck, every bit of the framework should be studied in connection with each other and in relation to the superficial anatomic features serving as landmarks, from which the needle is best directed toward the nerves. The hyoid bone, thyroid cartilage, row of transverse processes threaded by the vertebral vessels and each holding in its ridge the cervical nerve as it emerges from the intervertebral foramen and passes behind the vertebral vessels; the carotid arteries, internal jugular vein, the sternocleidomastoid muscle, the mastoid process, the external jugular vein are all closely related to one another for the purposes of regional anesthesia. The surgeon who attempts to block the cervical nerves should be able to visualize all these structures so as to reach the deep landmarks with as little injury as possible to the blood-vessels; not because the prick of the needle is harmful to the wall of the blood-vessel and might produce an aneurysm, for such mishap has not as yet been reported, that the author knows of, but because a hematoma

thus created distorts the anatomic features of the region and is occasionally misleading, apart from the fact that in certain cases it stands in the way of the surgeon's knife.

In connection with paravertebral and sacral block, special attention should be paid to the size and shape of the vertebræ and the relation which they bear to one another, the size and direction of their transverse processes, their depth beneath the skin, the general direction of the ribs, their height and thickness, the average space between two consecutive ribs, the shape and general direction of the sacrum with its two lateral rows of foramina, and their relation to the posterior superior spine of the ilium. Palpating and locating most of the prominences of the framework is always possible in lean patients; but in fleshy individuals little information is gathered by palpation, and the greater part of the anesthetist's work devolves on his mental sight of the underlying skeleton, his tactile sense of the few deep indeterminate bony surfaces being the only guide for the reconstruction of the region and the location of the nerves intended to be blocked. A thorough knowledge is required of the path of the nerves from the intervertebral foramen to the costal angle, the general direction of the lumbar nerves, their relation to the body of the vertebræ and transverse processes; the shape, position, thickness of the sacrum, and the contents of the sacral canal; the formation of the sacral plexus on the anterior aspect of the sacrum. The distribution of the spinal nerves should also call for special attention in the upper region of the thorax as well as in the lower part of the trunk.

The recent literature on abdominal surgery under regional anesthesia and experimental studies on the sensibility of the abdominal organs contains a wealth of information on the sensory innervation of the abdominal cavity and its contents, leading to a better understanding of the necessity for delicate handling of this region in the course of operative procedures.

Injections of methylene-blue in the human cadaver, followed by clean dissections, greatly help in acquiring rapidly the principles of technic prior to injecting patients; but the tactile sense of the nature of the tissues approached in the deep structures of the body can only be learned

by practising on the living being, executing scrupulously the procedures described for each operation.

Requisites of the Anesthetist.—If the anesthesia is induced by the surgeon himself, his success will greatly depend on his skill in using the regional method, assuming that he has thoroughly mastered its principles. But the question is whether or not specialists in regional anesthesia will not, in the near future, be called to do the work for the surgeons, just as trained anesthetists are asked to administer general narcosis. The author has already demonstrated that it is possible for a man to induce regional anesthesia for another man. In many instances the operation is performed as conveniently as under general narcosis, since the surgeon who is used to ether or gas finds no difference except the advantageous condition of complete relaxation of the blocked area, without the possible dangers attending deep narcosis. But in the majority of cases he must be familiar with the method and should scrupulously observe its principles, if he is desirous of completing the operation without the aid of general anesthesia.

Gentleness is the first requisite of the anesthetist. He should handle his needle and his patient with equal dexterity. Apart from the special knowledge of anatomy which he is bound to possess, the anesthetist must be familiar with the technical details and possibilities of the proposed operation, so as to be able to anesthetize the correct operative field. Information should, however, be obtained from the surgeon as to the type and extent of the proposed operation. The wider the anesthetic field, the greater the facility for surgical manipulation.

The anesthetist should be able to administer ether by the open method, which is the easiest and safest method of general anesthesia in the hands of the average man, so as to allow the surgeon to complete the operation in the absence of a professional ether or gas anesthetist.

It is unnecessary to lay stress on the importance of asepsis. The operative field should be prepared as for any surgical act. The anesthetist may not wear gloves if they should in any way interfere with his activities, but on no account should the instruments be manipulated unnecessarily. The point and shaft of the needle should not be touched, nor that part of the syringe which, when being refilled, is dipped in the

solution. The following rules should be observed; and although most of them are to be found under the different subheads of this chapter, their importance greatly justifies their insertion here:

1. Needles and other instruments should be tested before use, so as to make sure of their efficiency.

2. Solutions should be fresh and of accurate strength, the more so when they are intended for a poor surgical risk.

3. Adrenalin should be added to the anesthetic solution just before use.

4. Colored solutions of adrenalin should be discarded.

5. Anesthetic wheals should be raised wherever the skin is to be punctured, except in the palm, sole, and scalp in certain cases.

6. The needle should be introduced through the wheal at right angles to the skin surface.

7. The needle should not be previously fitted on to the syringe when it has to be introduced in the vicinity of large blood-vessels.

8. Bones serving as deep landmarks should be approached lightly with the needle, since the periosteum is very sensitive.

9. No attempt should be made to hit the nerves; extraneural or paraneural injections are sufficient for surgical anesthesia. But if the needle happens to hit the desired nerve, it should be stopped and the injection carried on at once.

10. Before injecting, it is advisable to wait a few seconds before adapting the syringe, and also to aspirate, so as to make sure that the point of the needle is not lying in the lumen of a blood-vessel, in which case, the needle should be drawn back a few millimeters and its direction changed before proceeding any further. A small hematoma caused by the accidental wounding of a blood-vessel with the fine needle is, however, of no clinical significance, but intravenous injections of the anesthetic drug may prove fatal.

11. Injections should be made slowly and the aspiration test renewed now and again, especially in paravertebral and sacral block.

12. Subcutaneous infiltration may be rapid, but steady and continuous, while the needle advances as well as when it is withdrawn.

13. No lateral pressure should be exerted on the needle for fear it breaks.

14. The breaking of a needle within the tissues should call the immediate attention of the anesthetist, who will himself extract the broken piece with greater facility, since he knows where it lies, unless it be situated too deeply to attempt extraction without the use of x-rays, in which case any other surgeon might interfere.

15. Care should be exercised not to break a needle in one of the sacral foramina, in the sacral canal, or close to the spine in the course of one of the paravertebral procedures, for these regions are not favorable for extraction, which is occasionally impossible.

16. The point of the needle should be drawn back in the subcutaneous tissue before any attempt is made to change its direction.

17. When the anesthetic procedure has been completed, the operative field should be tested with the point of a needle, or with a clamp if the patient's reaction to the pricks of the needle conveys any doubt as to the presence of anesthesia. If any part of the field is still sensitive to such painful stimuli, the responsible nerve or nerves should be located and supplementary injections made.

18. The patient should be sent in for operation completely anesthetized unless otherwise desired, such as in cases of intended combined anesthesia.

19. Any fainting condition of the patient should call for immediate attention and be treated by the subcutaneous injection of caffein, 0.25 gm.; spartein sulphate, 0.05 gm.; sodium benzoate, 0.30 gm.; and strychnin sulphate, 0.001 gm., put up in a 2 c.c. ampule. These are exceptional cases, such as those occurring after intravenous injections, or injections of large quantities of strong solutions, or the use of impure solutions; but the anesthetist should know how to handle these patients.

20. The anesthetist, whenever possible, should accompany his patient to the operating room and take care of him during the operation. A trained attendant may replace the anesthetist at the head of the patient; but on no account should the patient be left alone. He needs intelligent watch and occasionally friendly encouragement.

En résumé: The "Regional Anesthetist" should have a thorough knowledge of anatomy, a good training in general surgery, and a complete command of the principles of the method of regional anesthesia.

Special Education of Surgeon and Assistants.—The surgeon and his assistants should be familiar with the general principles of the method. They must at least know how to handle a patient who is conscious of everything and willing to go through the operation without the aid of general narcosis. The following rules, if strictly observed, will lead to most gratifying results:

1. As soon as the patient is on the operating table the assistants should make sure that he feels comfortable and see that he is not held thereon with too much restraint. The discomfort due to position is often an ordeal greater than the operation itself.

2. When preparing the operative field gentleness should be used, and care exercised, in clamping the towels, not to clamp the skin beyond the limits of the anesthetized area. The non-observance of this precaution is followed by constant groaning, which leads the inexperienced surgeon to believe that there is operative pain.

3. The patient should not be told when the operation begins.

4. Incisions should be made a little longer than when using general anesthesia, thus exposing more freely the deeper layers and reducing trauma.

5. Sharp instruments should be used; cutting with the scalpel should be preferred to snipping with the scissors.

6. On no account should the tissues be torn through or bruised by rough handling with fingers or blunt instruments; sharp dissections make better technicians.

7. Retractors should be introduced lightly and opened out gradually. Pulling a retractor with such force as would drag the patient off the operating table, had he not been tightly fastened thereon, should not be allowed.

8. The hand should not be forced through an insufficient opening of the abdominal cavity and the gloved hand allowed rough contact with the visceral and parietal peritoneum, thus causing pain and creating favorable conditions for future adhesions.

9. Pulls on the tissues, more particularly on the viscera, should be light and gradual, so as not to give rise to unpleasant sensations referred to the tissues beyond the anesthetized area.

10. Extensive packing in the abdominal cavity should be avoided. In the Trendelenburg position the bowels have a tendency to collect in the upper abdomen. The surgeon should avail himself of this advantage. Too heavy packing is painful, and always attended by an involuntary reaction which causes the bowels to protrude from the wound; whereupon the surgeon attempts to re-establish continence by further packing, which in turn results in more marked natural reaction on the part of the patient, and thus a vicious circle is created. To overcome this state of things general anesthesia must be resorted to and the patient loses the benefit of the regional method. But if at the start, before entering the abdominal cavity, the table is inclined full angle one way or the other, or tilted on either side, and the patient asked to breathe naturally through the mouth, protection of the abdominal cavity can be realized, with almost no discomfort to the patient, after gently and gradually retracting the wound wide open.

11. The patient should not be questioned on the degree of sensibility of the operative field, unless it be necessary to control the results of an anesthetic procedure under experiment. But even then better information may be had by watching the patient's face, whose expression is, as a rule, most reliable. If there is actual pain, reactions will always coincide with painful stimuli. Groaning or moaning may be due to discomfort on the operating table, or to a nauseated condition frequently present in the Trendelenburg position or when handling the abdominal viscera, especially the stomach. This condition ordinarily disappears by deep breathing. It is necessary to make sure that the surgical act is really painful before general anesthesia is resorted to; and this is where the surgeon's experience of the method will help him control the patient's attitude, which might be simply psychologic. In no case, however, should a patient be left groaning or moaning and encouraged only by such words as: "I am nearly through," "You are doing fine," "Just a minute," and so forth, when long painful manipulations have still to be done. Whatever be the condition under which he is laboring, a few whiffs of ether or gas-oxygen should be given to calm him; otherwise he leaves the operating room with an extremely bad recollection of his operation. On the other hand, it is not a shame for

a surgeon to combine regional anesthesia with a first-stage narcosis if sensibility to pain has not been completely abolished or if there is lack of co-operation on the part of the patient. He should first look to the welfare of the patient for which the method of regional anesthesia has been devised, and do his utmost to help him through the operation. If something goes wrong, it is proof that the technic used is at fault. Any condition resulting from such faulty technic should be remedied at once.

12. On no account should manipulations go beyond the anesthetized area; if they are deemed necessary, supplementary injections should be made, or a first-stage narcosis resorted to, before attempting such manipulations; and in case there is pain, time should always be allowed for the patient to lose consciousness before painful maneuvers are resumed. Even then, no rough handling should be allowed.

13. Surgeons and assistants should not lean on the patient or against his fastened arms during the operation. Leaning on the patient's legs in the perineal position is extremely painful. Continued pressure on the thorax is detrimental to good breathing.

14. All operations should be started from five to ten minutes after the anesthesia has been completed, except when using caudal block alone, in which case it will be necessary to wait from twenty to thirty minutes.

15. An hour and a half is the average duration of surgical anesthesia; after which other injections should be made or general anesthesia administered as soon as the patient begins to feel pain. The operation should be suspended for a while and resumed only when anesthesia has set in.

Co-operation of Patient.—It is not sufficient to have mastered the difficulties of technic of regional anesthesia and to be expert in that special field of surgery to believe that perfect anesthesia will always be ensured. The co-operation of every one on the hospital staff is an important factor, that of the patient indispensable, unless narcotics be administered in such doses as would produce a semi-waking condition or twilight sleep. In localities where the method is used extensively, home education is acquired very rapidly by friends and relatives who

have been operated upon by the local method; but in countries where general anesthesia has been the almost exclusive method employed, every patient is anxious to go to sleep as soon as an operation is proposed to him. Nurses should learn how to educate such patients as soon as they are sent to the hospital, and should tell them all about the method; so that they will know what is expected from them during the operation. It is too late to try to explain anything immediately before or during the operation. It only helps to arouse suspicion and apprehension at the time when absolute quietude is desirable.

In advising the operation, whether or not the surgeon is satisfied that regional anesthesia should be limited to bad risks only or deems fit to apply it in any case whatsoever, he should do his best, at that very first audience, to talk it over with the patient. The advantages of regional anesthesia should be explained to him and every effort made to persuade him that there will be no pain, although the sense of touch, pressure, and pull will not be abolished. The patient should be told that only part of the body will be anesthetized and that he will be conscious all the time; but that a little injection given some time before the operation will allow him to go through without any apprehension. The patient should know that his co-operation is indispensable. Very few patients do not follow the advice of the surgeon in whom they have placed all their confidence. If the patient resists, he should be asked to think it over again; but in no case should the surgeon change his mind in presence of this first refusal, inasmuch as many patients are likely to accept regional anesthesia at the very last moment. This preliminary talk greatly facilitates the task of the hospital staff whose duty it is to contribute in winning the patient's confidence.

The patient should not be allowed to choose between general narcosis and regional anesthesia. He should only be advised, since he knows as much of these methods as of the surgical technic to be used in his case. The patient has ordinarily no choice in the type of operation to be performed, but leaves it entirely in the hands of his surgeon. The same principle should apply to the form of anesthesia under which the operation is to be performed. The surgeon should have confidence

in the method in order to inspire his patient with confidence. He should convince his patient by showing him a nice picture of the undeniable advantages of regional anesthesia over general narosis. It is the author's experience that many patients to whom the difference between the two methods is explained, express their consent to the former by saying: "Do as you think best, doctor," or "I will try it"; and if the surgeon uses a little judgment in not attempting on patients difficult to convince a technic with which he is not very familiar, his actual success on those who volunteer their consent will greatly contribute to home education and thus promote the wide-spread use of the method of regional anesthesia.

If it is advisable to use regional anesthesia in a particular case, the extra nervous condition of the patient is not a contraindication to the method, since the judicious use of morphin and scopolamin is likely to control it.

Preoperative Psychic Control of Patient.—As a routine procedure, a hypodermic injection of morphin, 0.01 gm. ($\frac{1}{6}$ gr.) and scopolamin, 0.0002 gm. ($\frac{1}{320}$ gr.), given at least one hour before the induction of anesthesia, is sufficient to dull the mentality of the apprehensive patient, without reducing to any great extent his consciousness which should be present for active co-operation. The injection of a smaller dose or of the same dose of morphin-scopolamin given at a later stage seems to act on some patients as an excitant rather than as a sedative. Scopolamin induces sleep, and morphin controls pain; when combined in doses not exceeding those just mentioned, these drugs produce a tranquil, somnolent state, and at the same time serve to reduce to a minimum the general sensibility to pain.

The use of morphin and scopolamin in such weak doses is not meant to produce, and in fact does not produce, a twilight sleep nor a semi-waking condition during which the surgeon loses control of his patient, but to give the patient a pleasant and obedient mood, without which it is sometimes impossible to proceed with the necessary manipulations for inducing anesthesia.

A second dose may be given half an hour after the first or even immediately after the anesthesia has been completed, in case of very

nervous patients or of extensive major operations. But individual cases should be considered in administering two doses of the combined narcotics. If during the manipulations for inducing anesthesia the attitude of the patient reveals sufficient psychic control, there is no reason for giving the second dose; it should be reserved for alleviating postoperative pain.

Although the use of a single dose of morphin-scopolamin is a routine procedure, it must be remembered that the main object of these drugs being to dull the mentality of the *apprehensive* patient, at the same time reducing his general sensibility to pain, they are seldom needed in poor surgical risks, whose general condition renders them indifferent to the world in which they live. Narcotics are therefore useless in borderline cases; they only serve to increase the operative risk.

Control of Psychic Condition of Patient in Operating Room.—A patient who has accepted to undergo an operation under regional anesthesia is entitled to every comfort on the operating table, so that he may be able to go through the operation with as little uneasiness as possible. A thick, soft cushion covering the whole surface of the table should be used and the patient held thereon with as little restraint as possible. Shoulder, kidney, and leg rests should always be lined with thick soft pads. The patient should be placed on the operating table in the correct position for Trendelenburg, whatever be the operation to be performed. Surgeons and assistants should avoid leaning on or against the patient, as is occasionally done when operating under general anesthesia. If the patient is unwilling to be conscious of what is going on around him, his ears should be plugged with cotton and his eyes bandaged; but in the majority of cases better results are obtained by diverting the patient's attention to some other pleasant topic. The attendant at the patient's head should know how to use his or her judgment in seeking to divert the patient's attention or leave him alone if he feels sleepy and does not protest. The patient should never be told when the operation begins and such questions as "Do you feel that?" "Does that hurt?" and so forth, are strictly forbidden, because they are suggestive of pain and ruinous to the method. If it hurts, the patient will say so. He only needs encouragement when he is anxious, or when

the length of the operation begins to be a burden, or during an exceedingly short stage of painful manipulation. If painful maneuvers, uncontrollable by other injections, are likely to last more than a few seconds it is preferable to give a few whiffs of ether or gas-oxygen. Morphin and scopolamin make the mouth and lips dry. Patients who have had a preliminary injection of these drugs greatly appreciate a wet, cold sponge between their lips, a few sips of water or black coffee, if the nature of the operation permits. Wet cold sponges on the forehead and neck, as well as deep breathing, improve the occasional nauseated condition present in some patients who are very sensitive to narcotics, or during operations on the abdominal organs, especially the stomach. The sinking sensation which very often is incidental to manipulations of the abdominal organs should not be mistaken for pain. After making sure that there is no pain, by watching the patient's attitude to painful stimuli, the patient should be asked to take a few deep breaths and to keep on breathing naturally through the mouth. If he tries to vomit, his nostrils should be held tight by the fingers, so as to compel him to breathe through the mouth, thus relaxing the abdominal wall and improving the condition. If the surgical maneuvers seem to be painful, a first-stage narcosis is a real test for the degree of sensibility of the operative field. If the operation can be resumed as soon as the patient has lost consciousness, it means that the regional anesthesia was only partial, but almost good; or that regional anesthesia was present, sensibility to pain had been abolished, but that tactile sense was interpreted as pain. In other words, the patient felt the surgeon working and could not stand it. The odor of ether, or occasionally the presence of an inhalation mask on the face of the patient, is sufficient to control his mental attitude if regional anesthesia is present.

A first-stage anesthesia or analgesia is, therefore, in the majority of cases all that is necessary to calm the patient, unless there is sufficient evidence that the induction of regional anesthesia has proved a complete failure; in which case, he must be put to sleep until the surgical stage of anesthesia is reached.

It occasionally happens that a patient, through faulty technic in

the preoperative care he was entitled to, has accepted the manipulations for inducing regional anesthesia with little or no resistance; but, as soon as he reaches the operating room, he is unwilling to undergo the operation without being put to sleep. It is advisable not to displease him. The surgeon should get ready to start the operation, and, immediately before incising the skin, have a few whiffs of ether given, just enough to allow the patient to get the odor. If the regional anesthesia is good, there will be no more trouble during the operation. A few more drops of ether will be given only on the patient's demand.

In administering a general anesthetic, with the view to controlling the alleged pain or psychic condition of a patient to whom regional anesthesia has been induced, the anesthetist should therefore feel his way lightly and gradually, thus trying to avoid the excitation period, most troublesome to the surgeon in the course of abdominal operations. The ether or gas anesthetist should understand these various conditions of a patient under his care, and by his experience co-operate most intelligently with the regional anesthetist and the surgeon in the welfare of such an irresponsible patient.

Instrumentarium.—The implements for inducing regional anesthesia are composed of a special 10 c.c. syringe, with a set of fine needles of different dimensions, an ordinary 2 c.c. Luer syringe, three graduated glass measures, and two glass cups. A spare syringe and a set of needles should always be at hand.

Special Syringe.—A glass syringe should always be preferred to an all-metal one, since it is absolutely necessary to control its contents at any stage of the procedure, especially when making the aspiration test for blood or cerebrospinal fluid, when the needle has been introduced in the vicinity of large blood-vessels, or close to the vertebral column, or within the sacral canal. Leakage of the plunger with a back flow of the anesthetic fluid is noticed immediately, and the knowledge of the quantity of fluid injected is accurate, which is of some importance when the 1 or 2 per cent. solution is used.

The barrel of the syringe is, therefore, of transparent glass, which is more easily cleaned, but its plunger is metal. Both parts are ground to fit each other air-tight. The barrel has a capacity of 12 c.c.; but the

graduation at its distal end leaves a space of 2 c.c. behind the plunger, thus making aspiration possible as soon as the syringe is connected with the needle and before any fluid is injected. The barrel is closed by a metallic cover screwed on to it and provided with suitable wings for a good and easy grasp during the manipulations (Fig. 1). Its distal end bears an eccentric tip for adjusting the needle, and a bayonet lock which prevents the needle from flying off the syringe under pressure (Fig. 2). The eccentric position of the needle facilitates injection parallel with the surface of the skin and makes it easy to manipulate on very lean patients, especially in regions in which the prominences of the frame-

Fig. 1.—Labat's regional anesthesia syringe. Front view, showing the wings in a plane at right angles to the plane passing through the eccentric tip and bayonet lock. This position is realized when the cover bearing the wings has been screwed tight on to the barrel.

work stand in the way. All screw dispositions for fixing the needle to the syringe are of no practical value, since the needle has very often to be introduced repeatedly free from the syringe. Farr's pneumatic injector and self-filling syringes are contrivances which might be of some value for local infiltration; but these instruments cannot suit the purpose of nerve blocking, since definite small quantities of fluid must be injected slowly in the close vicinity of each nerve to be blocked. The weight of the syringe, as well as its shape, does not affect the stimulations of the tactile sense transmitted by the point of the needle passing through the various structural layers of the body.

For *sterilization*, the plunger should be detached from the barrel and both parts of the syringe dipped in *pure distilled water*. The addition of sodium carbonate or any other salt should be avoided, since these drugs are detrimental to the instruments and particularly to the anesthetic solution. The temperature is raised to the boiling-point and held for ten minutes. After boiling, the plunger is dipped in cold sterile water; while the glass barrel is allowed to cool, between two dry sterile sponges, to the temperature of the room. *On no account should the*

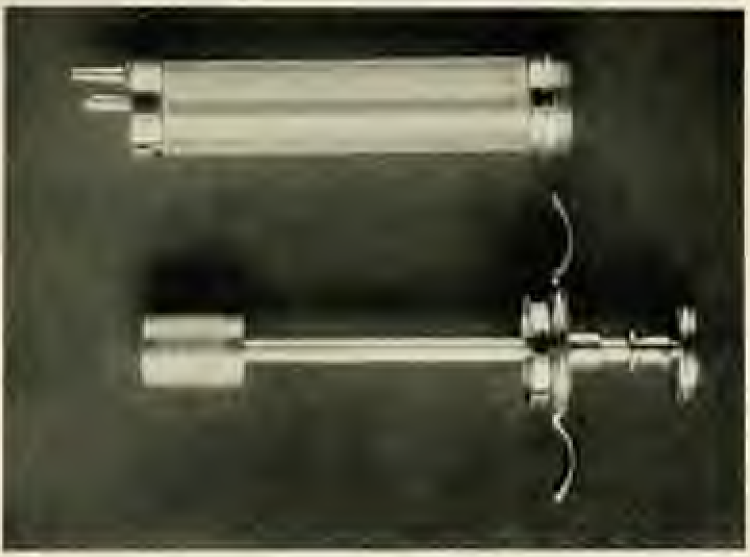

Fig. 2.—Labat's regional anesthesia syringe. Side view of the barrel; both parts of the syringe have been disconnected so as to show the eccentric tip and bayonet lock.

plunger be forced into the barrel when it is still hot. The diameter of the plunger, when hot, is greater than that of the barrel, and since both parts have been ground to fit each other smoothly when cool, the consequence eventually would be an immediate bursting or a progressive leakage between the two parts. Sterilization must be renewed for each patient. The syringe should be thoroughly cleansed in cold water before boiling, and when no longer needed it should be rinsed with 90 per cent. alcohol or ether, wiped dry with a soft sponge, and placed with the needles in a tray or the instrument case.

Needles.—The thinner the needle, the less the trauma to the tissues and the temporary or permanent damage to the blood-vessels or nerves; but the gage of the needle should be compatible with its length and such as would delicately transmit to the fingers an expression of the

Needles, No.	1	2	3	4	5
Length, mm.	30	50	80	100	120
Diam., mm.	0.6	0.7	0.8	0.9	1

Fig. 3.—Labat's regional anesthesia needles, provided with special bayonet lock hub. Note the slot on one side of the hub and the helix collar. The needle on the right side is in its protective shield and has its stylet in.

nature of the tissues approached in the deep structures of the body. Regional anesthesia needles should be flexible, but should not bend; they should be able to pass through all soft tissues with almost equal ease. They are, therefore, made of steel, highly polished or nickel

plated, and have a long bevel with very sharp point, so as to render their manipulations painless.

One set of needles is sufficient to meet the requirements of the various procedures for inducing regional anesthesia. It is composed of:

Fig. 1	Two finest intradermal wheal needles (No. 1). Two 50 mm. needles (No. 2). Two 80 mm. needles (No. 3). One 100 mm. needle (No. 4). One 120 mm. needle (No. 5).
Fig. 4	Two spinal puncture needles.

Each needle is provided with a metallic shield to protect its point and a brass wire or stylet to prevent its obliteration.

Fig. 4.—Spinal puncture needles, used also for epidural or caudal block. One of the needles has its stylet partly out, showing the device by which the stylet is held in position after being introduced its full length. The protective shield is shown separately.

The spinal puncture needle is made of nickel, and, being unbreakable, is preferred to the steel needle for epidural or caudal block. The special stylet with which the needle is provided increases its rigidity. Its short bevel is of great value in puncturing the sacrococcygeal membrane and advancing the needle up into the sacral canal. The length of the needle is 80 mm. and its thickness 1.1 mm.

For *sterilization*, the needles are first washed in cold water, outside and inside, by forcing water through their lumen by means of the syringe. The lumen is then rinsed in the same manner with 90 per cent. alcohol or ether and completely dried by forcing air through it. The

stylets are then passed in the fold of a sponge moistened with sterile neutral vaselin and introduced into their respective needles, which, thus prepared, are dipped in *boiling water* and allowed to boil for five minutes. After boiling, they are allowed to cool and dry between two sterile sponges. Sterilization must be renewed for each patient. When no longer required the needles should be washed with cold, then with boiling water, passed through alcohol or ether and completely dried before being placed with syringe in the tray or instrument case. The stylet should always be greased before being passed into the lumen of the needle, so as to prevent its oxidation and consequent obliteration.

Fig. 5.—Syringe for block anesthesia in dentistry. Schimmer needle and adjustment.

Needle No. 1 is used exclusively for raising intradermal wheals, through which the other needles can be passed painlessly. Needle No. 2 is intended for paravertebral cervical block, nerve-block at the wrist and ankle, and field-block of the scalp, fingers, and toes. Needle No. 3 serves for paravertebral dorsal block, brachial plexus block, abdominal field-block, and a few other nerve-blocks, such as those at the elbow, knee, and the root of the thigh. Needle No. 4 is used for paravertebral lumbar block, abdominal field-block, and great sciatic block. Needle No. 5 is restricted to presacral block and splanchnic analgesia;

but is of great help in abdominal field-block in very fat patients. Needles Nos. 2, 3, and 4 are used for transsacral block, according to the height of the puncture.

In dental surgery, preference is given to a 5 c.c. all-glass syringe of the Luer type (Figs. 5 and 6), since very small quantities of fluid must be injected under low pressure. Moreover, the manipulations are such that there is no necessity for an eccentric adjustment of the needle. The needle is always fitted on to the syringe by a screw disposition which prevents it from flying off under pressure. Injections are made with the needle previously attached to the syringe. Needles having no soldered joint are the best. The Schimmer needles (26 gage—42 mm.) are very satisfactory. They are easily and quickly changed, and owing to their very low price can be changed daily, the used ones being discarded entirely.

Fig. 6.—Syringe for block anesthesia in dentistry, showing adjustment connected for posterior superior dental block.

Graduated Glass Measures.—In hospitals, where the anesthetic solutions are prepared by the nurse in charge of the operating room, a practical way of reducing errors to a minimum is to have three glass measures graduated in centimeters. The largest (250 c.c.) serves to prepare the weakest solution (0.5 per cent.), that is, the one used in large quantities. The second in size (125 c.c.) is kept for the solution next in strength (1 per cent.), used in lesser amounts, and the smallest, restricted to the 2 per cent. solution, which is only injected in special cases. If the anesthetic procedure does not require large quantities of fluid, the largest glass may be discarded and the smaller ones used; but a relation should always exist between the strength of the solution and the size of the container, when different solutions are prepared at the

same time. Glass measures should be sterilized in pure distilled water, along with the instruments, and dried and cooled before use.

Glass Cups.—When the correct solutions have been prepared in the graduates, they are poured in cups ready to be utilized. Glass cups should be preferred to enameled ones because they are transparent

Fig. 7.—Labat's outfit for inducing regional anesthesia.

and their contents easily controllable. They should be of different sizes so as to avoid possible errors in the course of a procedure requiring solutions of different strengths. They should be rather flat, so that the syringe may be easily dipped into the solution and the whole of their contents aspirated without difficulty. They are sterilized at the same time as the graduates and in the same manner.

Luer Syringe.—The Luer syringe is used exclusively for hypodermic injections, preparatory to or following the anesthetic procedure.

The instruments composing the author's outfit are conveniently put up in a nickel-plated metallic case (Fig. 7), in which they can undergo sterilization either by boiling or by dry heat. This compact disposition is of great advantage to the anesthetist, who is thus able to carry his sterile instruments from one place to another without fear of contamination. It is also very useful in hospitals, where several outfits can be kept sterile and are ready for use in emergency cases. If the

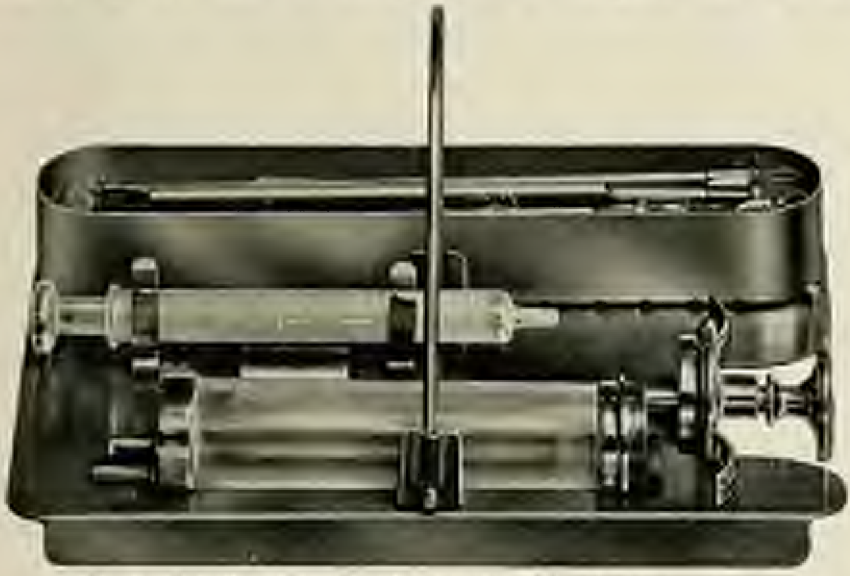

Fig. 8.—Labat's outfit. Tray bearing the whole set of instruments.

instruments are sterilized by boiling, the tray bearing the whole set of instruments (Fig. 8) is removed from the case and placed in an ordinary steam sterilizer. In this case, the trough containing the needles should be previously detached from the tray and the temperature of the water contained in the sterilizer lowered to prevent breakage of the syringes. The trough is replaced on the tray as soon as the water boils. In places where no steam sterilizer is available sterilization can be quickly realized by placing the case filled with distilled water on a Bunsen burner, alcohol lamp, or any gas or electric stove, following the aforementioned instructions relative to the trough containing the needles.

Novocain Solutions.—Novocain is beyond the experimental stage and is preferred to any other drug, because it fulfils the conditions of the best anesthetic agent hitherto known. Novocain is *para-aminobenzoyl-diethylamino-ethanol hydrochlorid*. It is not a derivative of cocain which is built up on the nucleus ecgonin. Novocain is the anesthetic of choice for the following among other reasons:

1. It is six to ten times less toxic than cocain.

2. Its toxicity is negligible when it is used in weak solutions and in such doses as are sufficient to produce surgical anesthesia.

3. It is not irritating to the tissues and is rapidly and completely absorbed locally, leaving no trace of its passage at the site of injection.

4. It is not decomposed by the addition of adrenalin to its solutions.

5. The addition of adrenalin to its solutions hastens and intensifies the action of the drug, and lengthens the duration of anesthesia. It thus becomes almost as active as cocain, which is the most powerful anesthetic agent known.

6. It can be sterilized by autoclaving at 110° C., since its melting-point is 156° C.

Novocain is readily and completely soluble in equal parts of water and also in normal salt solution, which is the vehicle *par excellence* for the purposes of regional anesthesia.

The solutions ordinarily employed are the 0.5 per cent., the 1 per cent., and the 2 per cent.

The 0.5 per cent. solution is used:

(*a*) For all minor operations.

(*b*) For major operations of relatively short duration. Example: Exploratory laparotomy, colostomy, etc.

(*c*) As a substitute for the 1 per cent. solution, when injecting poor surgical risks.

(*d*) In those parts of the body where it is not possible to inject the nerves individually. It is, therefore, chiefly employed for subcutaneous infiltration, and when injecting the deeper structures for the purposes of field-block.

The solution is injected in such relatively large quantities as are necessary to produce anesthesia by diffusion to the nerve filaments

contained in the structural layers injected. From 250 to 300 c.c. of the 0.5 per cent. solution may be safely used in the average patients. Individual cases *must*, however, be considered when handling very weak patients.

Equal parts of the 0.5 per cent. and 1 per cent. solutions are often used in field-block. The anesthesia begins earlier and lasts longer than when using the 0.5 per cent. solution alone.

The 1 per cent. solution is used:

(*a*) In those regions of the body where it is possible to reach the nerves individually, small quantities of the solution being deposited in the immediate vicinity of the nerves to be blocked. Ex.: Paravertebral block, sacral block.

(*b*) In those regions of the body where it is indispensable to avoid distorting the anatomic features of the operative field by subcutaneous infiltration. Ex.: Plastic operations on the face.

(*c*) When the edema created by the injection of larger quantities of a weaker solution is likely to cause too much pressure on the surrounding structures and possibly interfere with the circulation of the anesthetized area. Ex.: Fingers, toes, eyelids, orbit.

(*d*) When the reduced laxity of the tissues makes it impossible to obtain, by the injection of small amounts of a weaker solution, an anesthesia of sufficiently long duration. Ex.: Scalp.

From 125 to 150 c.c. of the 1 per cent. solution is considered a safe dose in the average patients, but here again individual cases must be considered when injecting patients of lowered resistance.

The 2 per cent. solution is used for blocking:

(*a*) The cranial nerves.

(*b*) The brachial plexus.

(*c*) The larger trunks of the economy. Ex.: Median, ulnar, musculospiral, sciatic and its main branches, and anterior crural.

(*d*) The sacral nerves by epidural or caudal injection.

Not more than 30 c.c. of the 2 per cent. solution should be injected in the average patients, and injection should be very slow, especially in the sacral canal, so as to avoid toxic symptoms.

Fresh solutions are the most effective. The simplest and quickest

way of obtaining fresh solutions is to prepare them by dissolving sterile novocain powder in sterile normal salt solution. Metz's procain, supplied in the crystalline form is very good. One of the most reliable products is the "Neocain" made by Corbière (Paris, France), which the author has been using for the last five years. It is put up in glass tubes, each containing two capsules of 0.50 gm. each. The neocain thus supplied is a sterile anhydrous powder. Sterile normal salt solution may be had on the market or readily made with sterile pure sodium chlorid and double distilled water. Each capsule dissolved in 100 c.c. of the saline solution gives a 0.5 per cent. solution of novocain, and if the contents of both capsules are poured in 100 c.c. of saline solution, a 1 per cent. solution is obtained, ready for use. Any other strength of solution may be thus extemporaneously prepared by varying the doses of the anesthetic drug. With *neocain* solutions analgesia begins almost immediately after the injection and lasts from two to three hours, except in very few instances; surgical anesthesia starts ordinarily from five to ten minutes after the last injection and lasts from an hour and a half to two hours.

When using the commercial procain it is necessary to sterilize the solution. The desired quantity of procain is gently boiled for one or two minutes in as much water as is sufficient to dissolve it (see Instructions, page 33), and poured into the largest graduate; sterile saline solution is then added until the desired dilution is reached and the solution is allowed to cool to the temperature of the room. Adrenalin solution is added immediately before use. The solution may also be prepared by raising sterile normal salt solution to boiling-point and adding the procain powder or crystals to it and allowing the solution to boil for one or two minutes at most. Theoretically, solutions thus prepared are only reliable if the procain is pure and nearly sterile; they have, however, been used by the author during several months without showing evidence of infection. But such solutions have been found to give anesthesia of shorter duration than when prepared cold with sterile neocain powder and sterile normal salt solution, although it has hitherto been admitted that novocain solutions can be sterilized by boiling without chemical decomposition or deterioration.

Moreover, the practice of preparing standard solutions and diluting them to the required strength may lead to confusion and irremediable errors. Beginners are always prone to inject more than is necessary to produce anesthesia. They ask for more solution, considering that the total quantity injected will still be so much within the limits of safety. If there has been some error in the preparation of the solution, the dose of novocain injected may thus be considerably increased and at times the lethal dose reached.

It is, therefore, preferable to use the novocain put up in capsules or tablets in accurate doses and prepare the solutions extemporaneously according to the needs of the particular patient.

As already stated, novocain is six to ten times less toxic than cocain; but still its toxicity must be remembered, especially when handling patients of low resistance. There is no established rule with regard to the strength and the quantity of solution to be used in a poor surgical risk, since it is impossible to know how poor is the risk. The experience of the anesthetist is the only guide.

Toxic symptoms due to novocain may be summarized as follows: (1) Rapid pulse; (2) palpitation of the heart; (3) frequent respiration; (4) labored breathing; (5) pallor of the face; (6) cyanosis of fingers, lips, and ears; (7) nausea; (8) vomiting; (9) cold sweats, and (10) a haze in front of the eyes. They are here given in the order in which they ordinarily appear, but pallor of the face may be the first symptom noticed.

The first four symptoms may be due to adrenalin as well, and are not serious. In such cases they are of very short duration, lasting from two to three minutes. They are most frequently incidental to rapid injection of small doses of either the 1 per cent. or the 2 per cent. solution; but they occasionally appear after subcutaneous injections of from 200 to 250 c.c. of the 0.5 per cent. solution. If these symptoms set in after the injection of a small amount of fluid, injection must be suspended for a while and resumed very slowly while the patient's condition is watched with great care.

Such symptoms as pallor of the face, cyanosis, nausea, vomiting, and cold sweats prompt the immediate subcutaneous injection of the

following cardiac stimulant: Caffein 0.25 gm., spartein sulphate 0.05 gm., sodium benzoate 0.30 gm., strychnin sulphate 0.001 gm., put up in a 2 c.c. ampule, always kept at hand. If the manipulations for inducing anesthesia have not been completed, they should be stopped immediately and no attempt made to resume the injections until the patient has completely recovered.

These serious symptoms are due to overdosage or are incidental to the injection of impure solutions. If not watched for and carefully avoided or treated when handling a poor surgical risk, they may prove fatal. Overdosage does not mean the injection of quantities over and above those generally considered as safe in the average patient; but the injection of such quantities and in such concentrations as are incompatible with the vital functions of the patient under consideration.

Fortunately, serious secondary effects following the judicious use of novocain solutions are extremely rare, and only happen when patients of very low resistance are injected by the inexperienced.

Novocain solutions are the safest.

Cocain solutions should never be used in regional anesthesia. Combinations of cocain and novocain are dangerous.

Adrenalin Solution.[1]—As a rule adrenalin solution (1 : 1000) is added to the novocain solutions in order to hasten and intensify the action of the anesthetic drug and lengthen the duration of the anesthesia. Adrenalin is not an anesthetic. Its real value depends upon its vasoconstrictor properties and the consequent anemia of the tissues under its direct influence. The anemic condition is such that the operative field is completely dry when the infiltration has been made along the line of incision; it is less apparent when the novocain-adrenalin solution is injected at some distance from the operative area, such as in field blocking. In nerve-blocking, hyperemia is the rule, although not to such an extent as would disturb the operative procedures. Apart from its direct action on the heart, adrenalin contracts the musculature of the blood-vessels, especially the capillaries at the site of injection, thus delaying the absorption of the novocain solution

[1] Also called suprarenin, suprarenalin, epinephrin, and so forth; but all prepared synthetically.

and reducing its toxicity. Absorption being thus reduced to a minimum by the closure of the capillaries, the slow destruction of the anesthetic drug locally prolongs the anesthesia.

Fifteen drops of adrenalin solution (1 : 1000) measured by the dropper are added to every 100 c.c. of the anesthetic solution, irrespective of the strength of the solution, without causing toxic symptoms or sloughing, inasmuch as this dose is very small and is, besides, injected in very weak solution (1 : 100,000 at least). With this concentration complete cessation of bleeding, such as occurs with the use of Esmarch bandage, has not been observed. The medium-sized arteries always bleed; but the oozing of the very small vessels is certainly much reduced. In paravertebral block there is, in the majority of cases, more bleeding of the operative field than with general anesthesia; but this is of no clinical significance because of its transient nature. The hyperemia thus produced is probably due to the inhibitive action of the adrenalin solution on the sympathetic system creeping along the arteries running side by side with the nerves blocked.

In simple goiter cases 10 drops only are added to 100 c.c. of the solution, and in exophthalmic goiter no adrenalin is used; but more time should then be allowed for the anesthesia to set in.

Adrenalin solution put up in sterile brown glass ampules is very convenient. Each ampule containing exactly 15 minims, or 20 drops, of adrenalin solution (1 : 1000) represents the average dose for one patient. The disadvantage of the adrenalin solution put up in bottles is that, once the bottle has been opened, it is hardly possible to resterilize the solution repeatedly until the bottle is emptied without spoiling it. No complications have, however, been observed with the bottled solutions several days after the bottle had been opened. Brown glass ampules should be preferred for their protection against light. All colored solutions, whether brown or pink, are, as a rule, discarded.

The subcutaneous or intramuscular injection of certain quantities of novocain-adrenalin solutions in the human being is ordinarily accompanied or followed by acceleration of the pulse and palpitation of the heart, very rarely by labored breathing. These symptoms are of short duration and have no influence on the general condition of the

patient, but should call attention and be treated in the manner described on page 27. They are most apparent in caudal or epidural block, although care is exercised to inject very slowly. After the injection into the sacral canal of about 10 c.c. of the 1 or 2 per cent. solution the patient spontaneously declares that his "heart is beating fast." The observer has, by that time, already noticed a marked increase in the pulse-rate. From two to three minutes is the average duration of these symptoms, which rapidly die out by deep breathing. Exceptionally there is pallor of the face or light cyanosis after the injection of relatively small doses of the weak solution (0.5 per cent.), and it is difficult to say how far the adrenalin is responsible for these symptoms, which are not peculiar to certain kinds of patients, but may happen in any case. The eventual intravenous injection of novocain-adrenalin partly explains this condition. Idiosyncrasy has probably something to do also; but the impurity of the drugs is, in the mind of the author, greatly responsible for the after-effects unless the patient has a very low-grade exophthalmic goiter, which the adrenalin test alone is able to detect.

The maximum dose of adrenalin that the average patient can safely take by subcutaneous or intramuscular injections is 30 drops. If the total quantity of solution to be used in a patient is likely to exceed 100 c.c., the dose per 100 c.c. is reduced accordingly, so as not to exceed the 30 drops, nor to inject a supplementary amount of solution without the addition of adrenalin. The best way is to take the approximate amount of solution required for the particular case and pour in from 15 to 25 drops of adrenalin, according to the quantity of solution needed, thus leaving a margin of 5 drops for further possible need.

The dose of adrenalin should vary according to the age and circulatory condition of the patient. It should be reduced in children, arteriosclerotics, elderly patients, diabetics, and those suffering from lesions of the vascular system, hypertension, and so forth, and not more than 10 drops should be given to such patients.

Instructions to Operating-room Nurse

In hospitals where, through pressure of work, the anesthetist has a special room, it is advisable to have written instructions for the nurse in charge of that room, so as to avoid confusion. In institutions where there is no necessity for such a room, these instructions should be in the hands of the surgeon's operating-room nurse.

Sterilization of Syringe.—*Pure distilled water should be used.* The addition of sodium carbonate or of any other salt is not allowed, for these drugs are detrimental to the instruments and particularly to the anesthetic solution.

1. Wash syringe in cold water.

2. Disconnect plunger from barrel and dip both parts in sterilizer, at low temperature; raise the temperature to boiling-point and boil for ten minutes.

3. Take plunger from sterilizer and dip in cold sterile distilled water.

4. Take barrel from sterilizer and allow it to cool between two dry sterile sponges in sterile tray.

5. On no account should the plunger be forced into the barrel when it is still hot.

6. Sterilization must be renewed for each patient; five minutes' boiling being then sufficient.

7. When no longer required, sterilize syringe as above, wipe dry with sterile sponge, and place plunger and barrel disconnected in tray.

8. Each tray should contain only one syringe and one set of needles, with two glass cups.

Sterilization of Needles.—*Pure distilled water should be used.*

1. Wash needles in cold water, outside with soft sponge and inside by forcing water through with syringe.

2. Wash stylets or wires and rub with soft sponge.

3. Connect needle with syringe and rinse lumen of needle with boiling water, then with 90 per cent. alcohol or ether.

4. To reduce moisture contained in lumen of needle force air through it with syringe.

5. Moisten sterile sponge with sterile neutral vaselin; pass stylets or wires in a fold of that sponge, and introduce stylets into needles.

6. Place needles in their respective protective shields.

7. Dip the needles thus protected in *boiling water*, in sterilizer, and boil for five minutes.

8. Take needles from sterilizer and let them cool between two dry sterile sponges.

9. When no longer required, wash needles as above (1, 2, 3, 4, 5, and 6), rub them with dry sterile sponge, and place in tray with syringe.

10. One set of needles should accompany each syringe in one separate tray.

11. One set of needles is composed as follows:

Two finest intradermal wheal needles.
Two 50 mm. needles.
Two 80 mm. needles.
One 100 mm. needle.
One 120 mm. needle.
Two spinal puncture needles.

12. The 120 mm. needle will not be sterilized unless on special demand for presacral block or splanchnic analgesia.

13. The spinal puncture needles, being only required for sacral block and spinal anesthesia, will only be sterilized in such cases.

14. Make the points of the needles after each day's work by gently rubbing on oil stone, but do not alter the slant of the original bevel.

15. Do not rub the shaft of the needles with sandpaper unless they have become too rough by rust. It is preferable to let them soak in gasoline for several hours and wipe them dry afterward with a soft sponge.

Preparation of Solutions with Sterile "Neocain."—Each tube contains two capsules and each capsule 0.50 gm. of neocain, thus making a total of *1 gram* of neocain per tube.

1. Take large glass measure (250 c.c.) from sterilizer and allow it to cool to the temperature of the room.

2. Pour in the required quantity of sterile normal salt solution after flaming the mouth of its container.

3. Drop in the contents of one or more capsules, according to the strength of the solution required:

1 capsule in 100 c.c. gives a 0.5 (½) per cent. solution.

2 capsules in 200 c.c. give a 0.5 (½) per cent. solution.

2 capsules in 100 c.c. give a 1 per cent. solution.

2 capsules in 50 c.c. give a 2 per cent. solution.

4. These solutions should be prepared immediately before use.

5. To save time, 100 c.c. of the 1 per cent. solution should be prepared as soon as the patient is brought in for anesthesia. This solution is readily converted into 0.5 per cent. solution by adding to it 100 c.c. of the sterile saline solution.

6. Adrenalin solution should never be added to the neocain solution until the anesthetist states what quantity is to be added.

7. Each adrenalin ampule contains 15 minims of a 1 : 1000 solution.

8. To open adrenalin ampule flame both extremities of ampule, break one extremity in the fold of a sterile sponge, hold the ampule in a vertical position over the glass containing the solution, and, in this position, break the other extremity. The contents of the ampule will immediately flow out. If only part of the contents of the ampule is required, the ampule should be opened while it is held horizontally.

9. Colored solutions of adrenalin should be discarded.

10. When using bottled adrenalin solutions a sterile dropper should always be at hand and great care exercised in handling the bottle, so as to reduce the risk of contaminating its contents.

Preparation of Solutions with Non-sterile Novocain or Procain.—To be prepared only when sterile neocain tubes are not available.

1. Prepare normal saline solution (0.90 gm. NaCl per 100 c.c. of distilled water), distribute in 100 c.c. bottles or flasks, sterilize, and keep in stock for a couple of days' work.

2. Be sure that each package of novocain has been labeled correctly; *Pure novocain—2 grams.*

3. Take 10 to 20 c.c. of the saline solution thus prepared, raise it to boiling-point, pour in one package of 2 gm. of novocain, stir for one or two minutes, and turn off the fire.

4. Pour about 100 c.c. of the saline solution in graduated glass

No. 1 (largest), add the hot novocain solution, and complete with saline solution to 200 c.c., so as to obtain a 1 per cent. solution.

5. Pour 100 c.c. of that solution in graduate No. 2 (medium). Add 100 c.c. of saline solution to contents of graduate No. 1. Graduate No. 1 (largest) thus contains 200 c.c. of 0.5 per cent. solution of novocain; graduate No. 2 (medium), 100 c.c. of 1 per cent. solution.

6. If there is any doubt as to the strength of solution (concentration) contained in any glass, throw it away, since irremediable errors may ensue.

7. To avoid confusion use larger glasses for weaker solutions, injected in large quantities; keep smaller ones for stronger solutions, thus giving a relation between size of glass and strength of solution.

8. Adrenalin solution should not be added to the novocain solution while this is still hot.

CHAPTER II

GENERAL PRINCIPLES OF TECHNIC

Position of Patient.—The recumbent position is the safest, the patient lying in the manner that best facilitates the manipulations for the particular procedure. For instance, on either side for paravertebral block, on the back in case of abdominal field-block, on the stomach for transsacral and caudal block, and so forth. Each of these positions is mentioned in the course of the description of the various procedures. He should rest very comfortably on the operating table during the manipulations. Soft cushions should be placed wherever need be, so as to obtain as complete relaxation as possible, thus rendering the landmarks more accessible to the palpating fingers, and the overlying structures softer to the needle.

The patient should be handled very gently, thus avoiding unnecessary stimulations, which are always detrimental to the final results aimed at by the preliminary injection of morphin-scopolamin.

Necessity for Asepsis.—Every effort should be made to avoid infection. As already stated, the operator may not wear gloves if they should in any way interfere with his tactile sense; but he should be scrubbed just the same as for any surgical operation and abstain from such maneuvers as would establish conditions favorable to local infection at the sites of puncture.

The operative field should be washed with benzin, disinfected with one coat of 5 per cent. tincture of iodin, and lastly washed with alcohol so as to destroy the excess of iodin detrimental to certain delicate skins. In the oral cavity a 3.5 per cent. tincture of iodin is quite sufficient to give a sterile field. The operative area should be protected by sterile towels exactly as in the case of a surgical operation. With the instruments and solutions placed at hand in a sterile tray or on an instrument table one is able to perform the different steps of any technic without risk of contamination.

The instruments and solutions being considered sterile, that part of the syringe which has had previous contact with the operator's hands or the patient's skin should not be dipped in the solution. The needle should be held by its hub, and once its point has been placed on the skin, it should not be moved about, but should be introduced directly at the proposed site of puncture, thus avoiding possible contamination of the deep structures by surface elements scraped by the needle and carried with it. If the needle is too long to be introduced without bending, its shaft should be held in the fold of a sponge, and not by the naked fingers.

Use of Needle.—All needles should be tested before use. Needles are, as a rule, sterilized with their wires or stylets in; but it occasionally happens that a needle is placed in the tray without its stylet in. In such a case the needle should be tested as to its efficiency by forcing the anesthetic fluid through its lumen by means of the syringe. Ordinarily, after withdrawing the stylet, the needle is attached to the syringe previously filled with the anesthetic solution, and its lumen washed with a few drops of the solution, so as to free it from any foreign substance, such as water of sterilization or vaselin. It is always disagreeable, if not a waste of time, to have to withdraw a needle that has been introduced correctly because it does not work.

The point of the needle and its shaft should be examined before use, so as to make sure that these parts are not damaged by rust. Rusty needles do not slide easily and occasionally break within the tissues. Some of them may have holes along their shaft due to progressive oxidation from within, thus allowing part of the fluid to escape laterally.

The needle should be held firmly by its hub, between the thumb and forefinger, so as to avoid possible contamination of its shaft (Fig. 9). Long needles which cannot be thus held without bending while they are introduced through the skin should be held in the fold of a sponge.

It is sometimes convenient to record the depth to which the needle has been introduced for taking a deep landmark or making an injection. This is done by means of a small piece of sterile cork, or rubber, threaded on the needle previous to its insertion. As soon as the desired landmark has been reached the recorder is slid close to the

surface of the skin. The needle may then be partially withdrawn and reintroduced in another direction until the recorder again touches the skin, or the recorder may be displaced a certain length on the needle, so that the proposed site of injection may be reached with greater accuracy in the deeper structures. Beginners are advised to use such a recorder especially when injecting the sacral nerves through the posterior sacral foramina (transsacral block), so as to avoid introducing the needle too deeply and unconsciously pouring the solution in the pelvis, or distributing the anesthetic in the superficial part of the foramen. The recorder is also very useful for the blocking of the maxillary and mandibular nerves by the zygomatic route.

Fig. 9.—Manner of holding the needle.

When making subcutaneous injections or infiltrating a wall of anesthesia in the course of the field-block procedure, the needle is previously connected with the syringe; but when the needle has to be introduced in the vicinity of large blood-vessels, it should not be previously fitted on to the syringe, and time should be allowed to make sure that no blood flows out of its lumen, in which case the needle should be slowly drawn back until the flow ceases. If the needle has to be advanced still further, its direction should be slightly changed. The aspiration test should be made and renewed now and again when injecting in the neighborhood of large blood-vessels, so as to make

sure that the point of the needle is not lying in the lumen of one of these vessels. The puncture of a blood-vessel with a fine needle has no clinical significance greater than that of a small hematoma, but it should be avoided, because the presence of blood at the site of injection is detrimental to the anesthesia, and for the other reasons set forth on page 4.

The needle should always be introduced perpendicular to the surface of the skin. Its point is placed in the center of the wheal and intro-

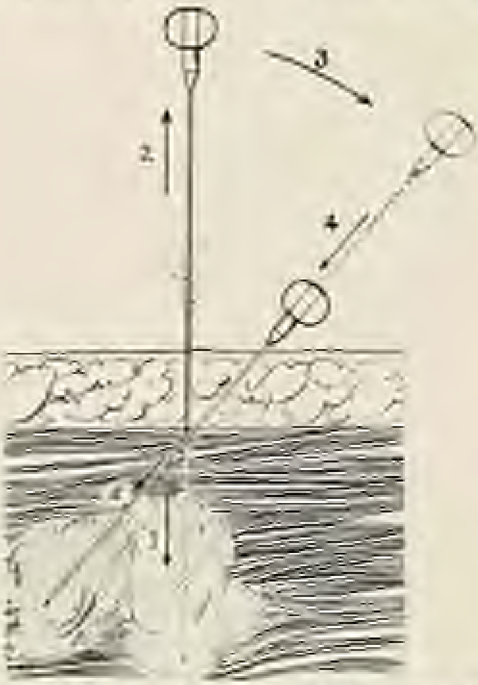

Fig. 10.—Manner of changing the direction of the needle: Arrows 1, 2, 3, and 4 illustrate the steps of the technic for injecting the deep structures at 1 and 4' (gray zones).

duced through the wheal by a sudden, short, and quick thrust. The needle thus introduced goes through the dense infiltrated derm more easily than when pushed through slowly. After piercing the skin the needle should be advanced slowly and gently and no pressure exerted laterally or out of its axis, for fear it breaks. In order to change the direction of the needle, its point should always be drawn back in the subcutaneous tissue (Figs. 10 and 11).

Bony landmarks should be approached gently with the needle, particularly to avoid damaging its point, which might break or bend into

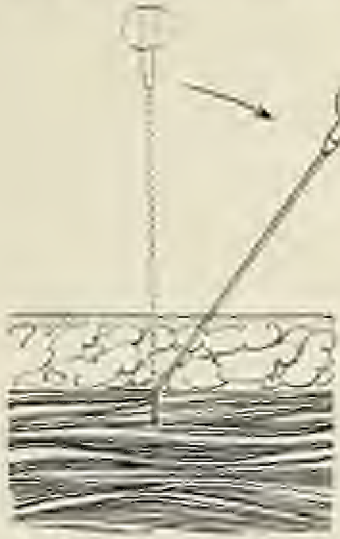

Fig. 11.—Poor technic in changing direction of needle.

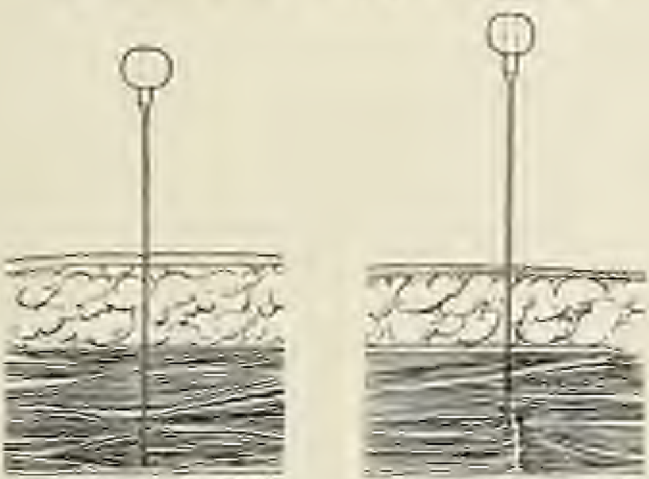

Fig. 12.—Result of rough approach of bony landmark.

a hook and tear through the tissues when the needle is withdrawn (Fig. 12). The periosteum is, besides, very sensitive and should be touched lightly.

The needle should never be introduced its full length, *i. e.*, as far as its hub, since it occasionally happens that the hub flies off under a muscular contraction of the patient, thus leaving the whole shaft within the tissues. It is therefore recommended to choose a needle a little longer than the approximate distance of the proposed site of injection from the site of puncture on the surface of the skin. A needle broken or lost in the subcutaneous tissue is easy of access; but if this mishap occurs in the course of the paravertebral or sacral block, chances are that the broken piece will have to stay where it is unless special operative steps are taken. This may happen to the most skilled, and although it is the author's privilege not to have had the misfortune of breaking a needle in one of his patients, he has seen it thrice in paravertebral and transsacral procedures, with two unsuccessful attempts to remove the broken piece. Cathelin says that this accident, happening in the sacral canal in the course of the caudal block, does not seem to have any grave consequences, judging by the fact that 2 of the patients he was asked to examine in this respect had no unpleasant symptoms six months after the accident. He himself happened to lose a whole needle in the sacral canal of one of his patients, although he had the experience of over 1000 sacral punctures. He was anxious to take it out; he spent twenty minutes over it, trying and at last succeeding in seizing it with a forceps, after incising the skin. As a rule such an accident should call for immediate intervention, unless the deep situation of the broken piece necessitates the help of *x*-ray pictures for its location.

Care and gentleness lead to dexterity, which reduces the risk to a minimum.

Use of Syringe.—The plunger and the barrel undergo sterilization after being disconnected from each other, as already seen (page 17). When adjusting these parts the barrel and plunger should be cold or, rather, at the temperature of the room; and, before sliding the plunger into the barrel, the plunger is dipped in the cup containing the solution, so as to moisten its wall, thus securing a smoother contact between metal and glass, both parts having been ground to fit each other air-tight.

Fig. 13.—Manner of filling the syringe. The eccentric tip is turned toward the dorsum of the hand.

Fig. 14.—Manner of holding the syringe when it has been filled. The thumb is applied to the plunger rod to prevent its displacement.

The cover is screwed on to the barrel and the syringe filled with solution, in the manner shown in Fig. 13, the eccentric tip being turned toward the dorsum of the left hand. The syringe thus filled is

then held between the middle and forefingers of the right hand, with the thumb resting on the cover against the plunger rod (Fig. 14), so as to prevent the occasional partial discharge of the syringe due to the displacement of the plunger. The needle is held firmly between the thumb and index-finger of the left hand, the bevel turned upward and the slot to the left. The hand holding the syringe is turned counter-

Fig. 15.—Manner of connecting needle with syringe. *First position*: The needle is fixed and the syringe rotates clockwise. Note the position of the needle, slot to the left and bevel upward.

clockwise until the dorsum of the hand faces upward (Fig. 15). The syringe is then adjusted to the needle and rotated clockwise 180 degrees, while the bayonet lock on the syringe enters the slot on the hub of the needle (Fig. 16), and slides along the helix collar to reach the position illustrated in Fig. 17. The syringe will then be in the correct position for injection, after displacing the thumb to the disk at the extremity of the plunger rod (Fig. 18).

When filling or refilling the syringe it is customary to dip its distal end in the solution. Care should, therefore, be exercised to avoid contaminating this part by repeated contact with the fingers during the act of connecting and disconnecting the needle. If the needle is always held by its hub, as already advised, there is no risk of contaminating

Fig. 16.—Manner of connecting needle with syringe. *Second position*: The rotation of the syringe has brought the bayonet lock in the slot and partly secured the needle.

the solution in that way. The syringe should be free from air when it is connected with a needle that has been stuck in the body of the patient. When injecting, no lateral pressure should be exerted out of the axis of both syringe and needle. The wrist should be free and flexible during all manipulations.

It must not be forgotten that the special regional anesthesia syringe has a capacity of 12 c.c. Graduations are marked up to 10 c.c., leaving a space of 2 c.c. behind the plunger to allow the aspiration test to be made before the injection is begun (see page 6). It thus follows that, if no heed is taken of this disposition, 2 c.c. more of the solution is

Fig. 17.—Manner of connecting needle with syringe. *Final position.* The bayonet lock has turned clockwise 180 degrees and completely secured the needle. The syringe is ready for use.

injected each time the syringe is emptied; and, as a result, the solution is exhausted before the required number of injections have been made. It is, therefore, imperative that the exact quantity of solution be taken each time in the syringe, in order to avoid using excessive doses of the 3 per cent. solution to complete the anesthesia, especially in the paravertebral and sacral procedures.

Landmarks.—Landmarks are the anatomic features of the body that serve to locate the nerves, or as reliable guides to approach them. They are of two kinds, viz., superficial and deep.

Superficial landmarks are the anatomic features of the surface of the body obtainable by sight or by palpation of the soft structures overlying the framework. They are used either as definitive landmarks, or as a means of approaching the deep landmarks. Examples of defini-

Fig. 18.—Manner of holding the syringe while injecting.

tive superficial landmarks are: *Blood-vessels*, when blocking the cervical plexus (external jugular vein), the brachial plexus (subclavian artery, axillary artery), the anterior crural nerve (femoral artery). *Muscles*, when blocking the cervical plexus (sternocleidomastoid muscle), the terminal branches of the intercostal nerves (recti muscles), and so forth. *Bones*, when blocking the ulnar nerve at the elbow (internal condyle and olecranon), and so forth. *Tendons*, when blocking the

median nerve at the elbow (biceps tendon), above the wrist (palmaris longus and flexor carpi radialis), and so forth.

Superficial landmarks are used as a means of approaching the deep landmarks, especially when blocking the trigeminus and its branches and in paravertebral and sacral block. They should be taken with great accuracy so as not to be misleading, and the patient should not be allowed to move after they have been traced on the skin.

Deep landmarks are those which cannot be defined by palpation. They are the only faithful guides of the needle in the depth; without them it is materially impossible to reach, with any accuracy, the immediate vicinity of the nerve to be blocked. *Bones* are the ordinary deep landmarks, but aponeuroses serve as well; for instance, the rectus sheath, within which the solution must be distributed, when blocking the operative field for laparotomy. They should be approached lightly and gradually, thus seeking to obtain the best information by the most delicate tactile sense. Beginners are advised to make preliminary tracings of landmarks on the skin either with a sterile dermographic pencil or an applicator moistened with tincture of iodin. Palpation should be light and smooth. The patient must be well relaxed during the various manipulations. His position on the operating table and the use of soft cushions establish favorable conditions and facilitate the approach of the deep landmarks.

Intradermal Wheal.—An intradermal wheal is a small disk of infiltrated derm raised in the following manner: The syringe is filled with 0.5 per cent. solution, and the finest needle (No. 1) attached to it, with the bevel turned upward, that is, toward the axis of the syringe. The syringe and needle thus connected are held almost flat on the skin with the point of the needle lying at the site of the proposed wheal, while the skin is stretched in the opposite direction by the index-finger of the left hand placed close to the needle. The point of the needle is then introduced into the derm *until its bevel has entirely and just disappeared*, and a few drops of the solution injected with a little pressure. A white "orange peel" disk or wheal is thus raised, which instantaneously becomes insensitive (Fig. 19).

If the point of the needle is allowed to reach the subcutaneous tissue

the "orange peel" is not produced, and no wheal therefore raised through which the other needles can be passed painlessly. If too great quantities of the solution are injected the wheal becomes dense and difficult to penetrate with the other needles. This can be avoided

Fig. 19.—Intradermal wheal. Note the position of the syringe which is almost parallel with the surface of the skin.

by stopping the injection as soon as a change is noticed in the aspect of the skin. Intradermal wheals disappear a few minutes after they have been raised, leaving but a red speck at the site of puncture. Wheals are raised wherever the skin has to be punctured. In those parts of the

body where the skin is thin and movable a fold of the skin is taken between the thumb and index-finger of the left hand, and the needle inserted at the summit of that fold and almost tangent to the skin surface at the site of puncture. In certain parts of the body, such as the scalp, intradermal wheals cannot be raised unless the fluid is injected with considerable pressure, and the prick of the finest needle is occasionally as painful as that of the needle to be used subsequently. Intradermal wheals are, therefore, avoided in those regions if there is much reaction at the first wheal raised. They should never be infiltrated in the palm or sole, injections in these regions being carried on from the dorsal aspect of the hand or foot.

The intradermal wheal[1] has three aims:

1. It helps to win the confidence of the patient; because it is almost painlessly raised and allows the needle to pass through the skin without pain.

2. It serves as a superficial landmark.

3. It indicates the extreme limits of the anesthetized area, beyond which surgical manipulations need subsequent infiltration or the use of general narcosis.

Field-block consists in creating walls of anesthesia encircling the operative field. The solution is distributed fanwise in certain definite planes of the body so as to soak all the nerves crossing these planes on their way to the operative field.

The principal advantages of field-block which speak in favor of its universal adoption are: (1) absence of distortion of the anatomic features along the line of incision; (2) anemia of the tissues within the blocked area, due to the vasoconstrictive effects of the adrenalin contained in the novocain solution; and (3) muscular relaxation with greater facility for the use of retractors. The principal objection to direct local infiltration is the frequent occurrence of defective healing of the surgical wound.

The anesthesia produced by the field-block method is also of longer duration than that following local infiltration. It is chiefly due to the

[1] For the sake of brevity the word "wheal" will be used instead of "intradermal wheal" from this page on.

fact that, with the block method, almost the total quantity of the anesthetic fluid is retained at the site of injection and is slowly and gradually destroyed locally; while with local infiltration the sectioning of the tissues through the edema produced by the injected fluid allows part of the solution to escape rapidly.

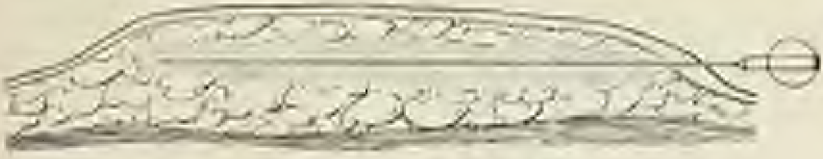

Fig. 20.—Subcutaneous infiltration.

Field-block differs from nerve-block in that by the former no attempt is made to aim at the nerves individually, as is the case when injecting the cranial and spinal nerves, at their exit from the various foramina or at other accessible points on their way to the periphery. The solution is distributed in such a way as to reach all the nerves lying within the infiltrated tissues and block them all at a time.

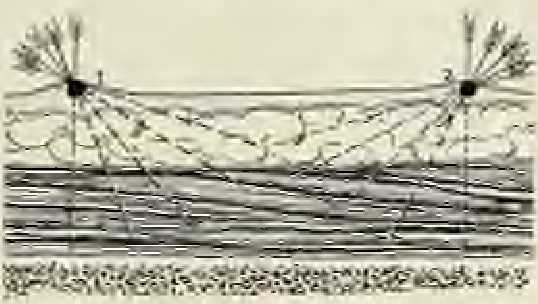

Fig. 21.—Manner of creating a wall of anesthesia: 1 and 2 are the points of entrance of the needle through wheals raised on the surface of the skin. The needle is introduced first perpendicularly, then more and more obliquely, in one and the same plane passing through 1, 2, and the solution evenly distributed while the needle is advanced as well as when it is withdrawn.

Field-block may be realized in different ways:

1. By infiltrating a subcutaneous wall of anesthesia (Fig. 20), or by creating walls of anesthesia perpendicular to the skin surface and involving the entire thickness of the structures in which the nerves lie (Fig. 21). These walls are at least four in number, meet at their ex-

tremities, and have ordinarily the shape of a rhombus (Hackenbruch), along the greater diagonal of which lies the proposed line of incision

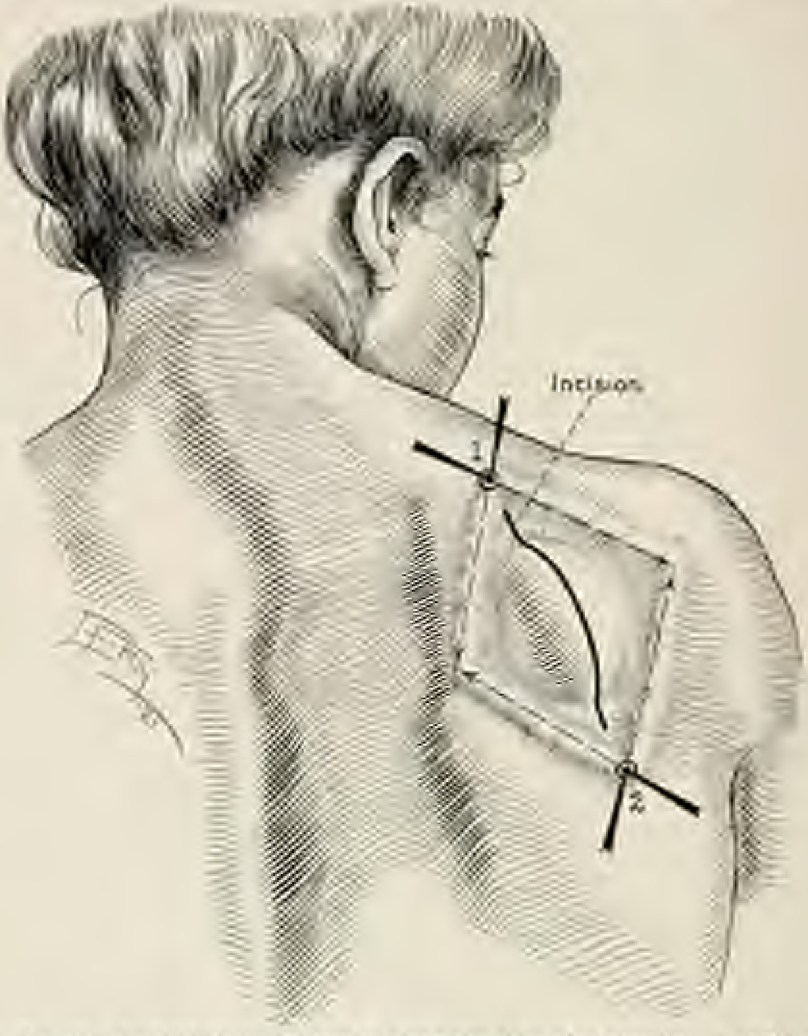

Fig. 22.—Field-block by infiltration along the sides of a rhombus: 1 and 2 are wheals raised at the extremities of the intended line of incision. The arrows indicate the direction of the needle.

(Fig. 22). If the operative field is too wide to be circumscribed by a rhombus, any other polygon is described around it.

2. By creating walls of anesthesia obliquely to the skin surface, involving only part of the tissues of the region, but meeting in the

depth in such a way that the operative area is contained in a "cup" of anesthesia. This procedure applies to the excision of benign super-

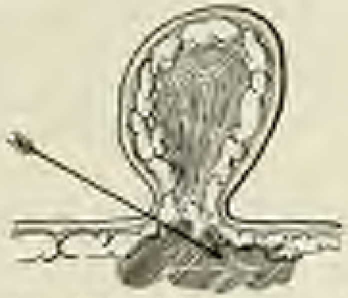

Fig. 23.—Infiltration of the pedicle of a very small benign tumor.

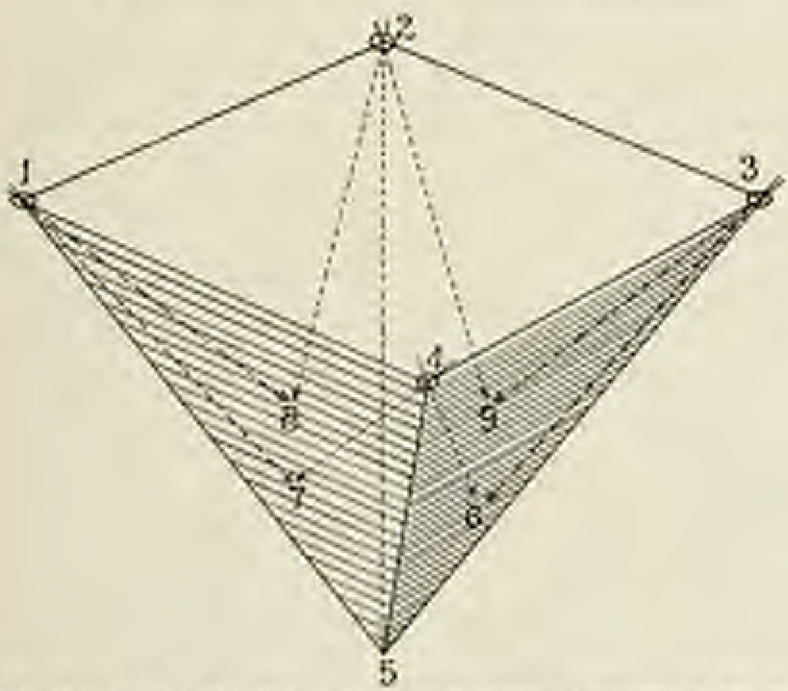

Fig. 24.—Pyramid field-block: 1-2-3-4 are the points of entrance of the needle on the surface of the skin; 5 is the apex of the pyramid, in the depth. The solution is distributed fanwise along the planes passing through the sides of the pyramid, as shown by the arrows, always more and more obliquely until the subcutaneous tissue is reached.

ficial tumors, or extraction of foreign bodies lying in the superficial structures. The "anesthetic cup" may have the shape of an inverted pyramid (Fig. 24), its base being the surface of the skin. By modify-

ing the number and direction of the anesthetic walls it is possible to obtain cups of some other shape suitable to the particular case (Fig. 25).

3. In certain parts of the body a single wall of anesthesia is sufficient to meet the requirements of the proposed operation. For instance, by creating a wall of anesthesia along the costal margin (Fig. 26), or between the costal margin and the iliac crest (Fig. 27), or

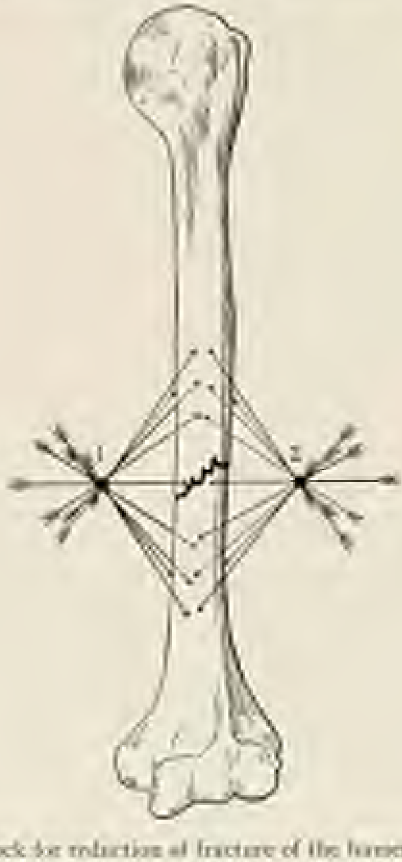

Fig. 25.—Field-block for reduction of fracture of the humerus: 1–2 are the points of entrance of the needle on the surface of the skin. The solution is distributed in the direction of the arrows.

combining both procedures on the same or on both sides, it is possible to obtain wide areas of anesthesia of the upper, lower, or entire abdominal wall (Fig. 28). With an exact knowledge of the nerves crossing the proposed anesthetic wall and of the skin distribution, one can easily tell what will be the anesthetized area.

Nerve-block is the "physiologic section" of a nerve, at any level, produced by an anesthetic fluid and resulting in the anesthesia of the territory supplied by that nerve. It may be realized in two

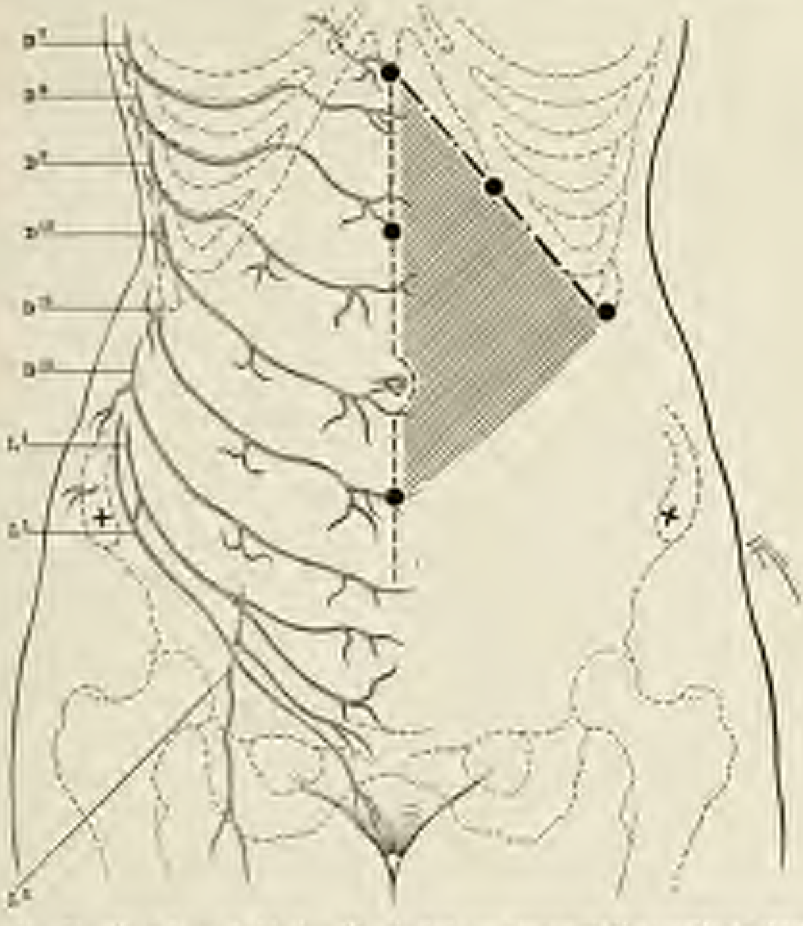

Fig. 26.—Costal margin block. The shaded area represents the anesthesia obtained after infiltrating along the costal margin only. If the operative manipulation is extended to the midline, or in case of a postoperative hernia in the shaded region, it is necessary to infiltrate subcutaneously along the midline, as illustrated. The dots represent wheals.

ways: (1) By intraneural injection, which may be performed either after exposing the nerve and depositing the solution within the nerve sheath, or by injecting the solution within the nerve sheath by means of a needle introduced through the soft tissues overlying the

nerve. (2) By extraneural or paraneural injection, which consists in depositing the solution in close proximity to the nerve, which is thus reached only by diffusion. *Intraneural injections* are not advised for surgical purposes. The exposure of a nerve is already a surgical act of

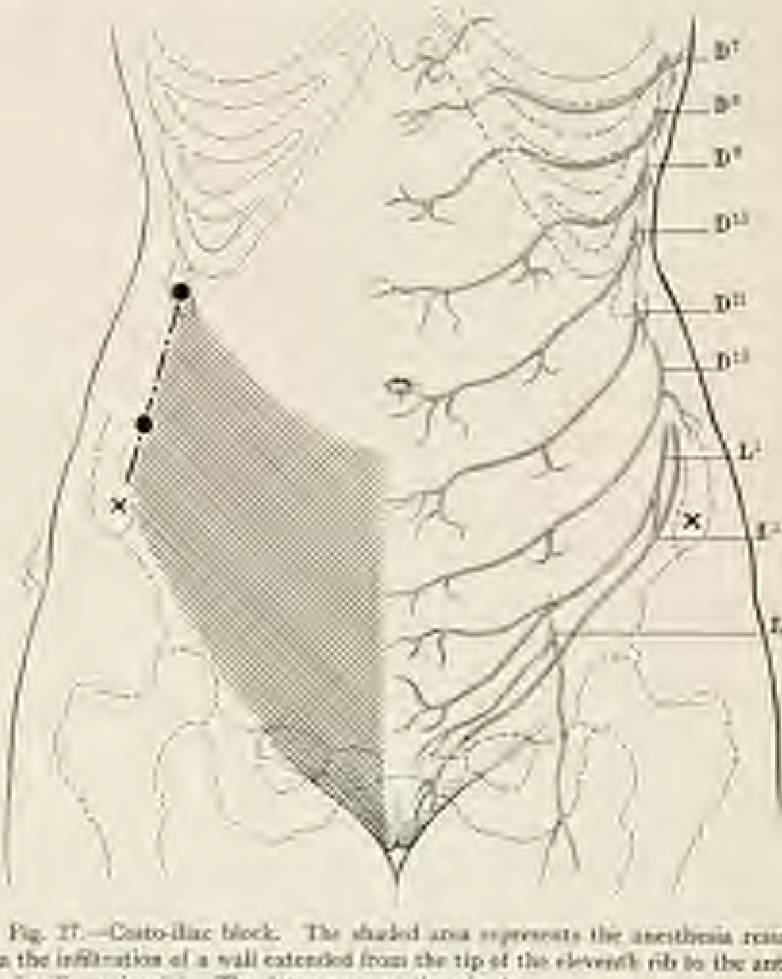

Fig. 27.—Costo-iliac block. The shaded area represents the anesthesia resulting from the infiltration of a wall extended from the tip of the eleventh rib to the anterior superior iliac spine (x). The dots represent the wheals.

greater importance than the simple injection of the nerve from without. Although the anesthesia produced by intraneural injections is instantaneous in most cases, this procedure is occasionally followed by postoperative neuralgia. *Extraneural injections* are not painful, while

intraneural injections produce shock, especially when they are repeated on several large trunks. They give as good anesthetic results, provided the solution is not injected too far from the nerve and the correct strength of solution used. It is hardly necessary to wait more than

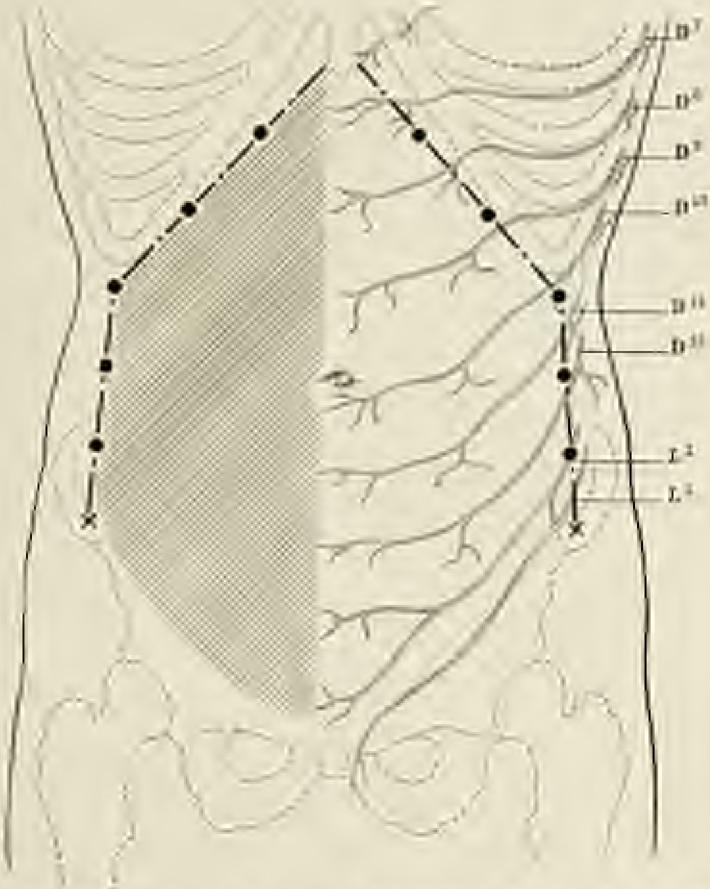

Fig. 28.—Field-block of one-half or entire abdominal wall. Costal margin block and costo-iliac block combined (see Figs. 26 and 27).

five minutes if the injected fluid has been deposited in the immediate vicinity of the nerve.

Nerve-block does not, as a rule, give a dry field. Contrary to what is expected, there is more bleeding, due to the action of the anesthetic fluid on the sympathetic chain accompanying the blood-vessels; but,

as already stated, the hemorrhage is only transient and does not interfere with the operation.

Sensibility is abolished; in very rare instances motility is lost. For instance, after a brachial plexus block almost all patients are able to move their forearm, wrist, and fingers during the operation, although the normal function of the limb is greatly altered. There is always a loss of tonicity of all the muscles, realizing a state of paresis rather than paralysis. Nerve-block produces such a complete physiologic section of the nerve at the site of injection that the largest trunk of the economy may be traumatized, bruised, or cut through without evidence of the slightest symptom of shock. The patient has sometimes no notion of what is going on and his face bears no sign that would suggest the idea that stimuli from the periphery are being registered by the brain; in the majority of cases the pulse-rate and blood-pressure remain normal.

Before inducing a nerve-block the patient must always be asked to signal, on the spur of the moment, the appearance of any paresthesia or radiating sensation. It avoids unnecessary trauma to the nerve and gives an accurate knowledge of the nerve reached by the point of the needle.

CHAPTER III

BLOCKING OF CRANIAL NERVES

GASSERIAN GANGLION BLOCK

(Blocking of the Gasserian Ganglion)

THE trigeminus, fifth cranial nerve, extends from the pons varolii to the apex of the petrous portion of the temporal bone. Here the large dorsal sensory root forms the gasserian ganglion, while the thin ventral motor root passes beneath the ganglion and unites with the third expansion of the ganglion to form the inferior maxillary or mandibular nerve, which leaves the skull through the foramen ovale. The gasserian ganglion lies in a capsule formed by a splitting of the dura, is intracranial, and accessible through the foramen ovale. The foramen ovale is really a canal about 1 cm. long, and the gasserian ganglion is situated at its posterior extremity. Its shape is oval in the average number of cases, its length or greater diameter measuring from 5 to 11 mm. and its breadth or smaller diameter 2 to 7.5 mm. Difficult cases to inject are those in which the breadth is only 3 mm.; but these happened only in about 8 per cent. of the skulls examined by Härtel. The foramen ovale is in most cases filled by the third branch in such a way that, to reach the gasserian ganglion, the needle inevitably strikes the nerve at the entrance of the canal and induces paresthesias in its territory.

The situation of the foramen ovale, at the base of the pterygoid process, varies with the skull; but the chief landmark is the smooth infratemporal plane, which is anterior to the foramen and with which the needle must come in contact before it reaches the foramen ovale.

Three superficial landmarks are ordinarily taken, so as to establish the direction in which the needle should be introduced through the deep structures, in order to reach the infratemporal plane:

(*a*) A point situated at the level of the second upper molar tooth. This point is about 3 cm. lateral to and a little above the angle of the mouth.

(*b*) The pupil of the eye, on the same side.

(*c*) The midpoint of the zygoma, on the same side.

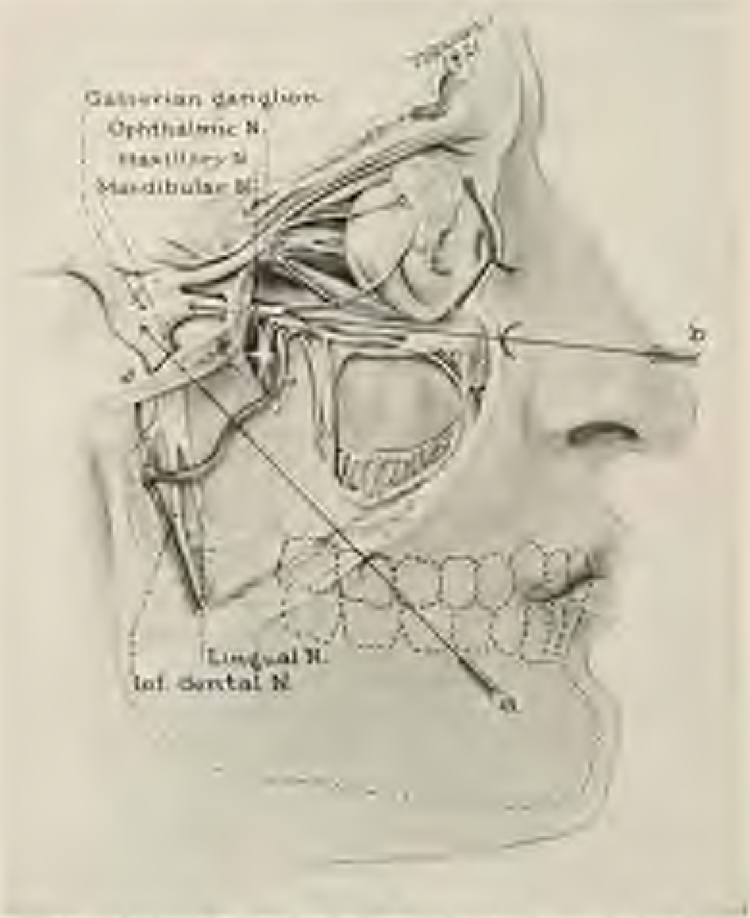

Fig. 29.—*a*, Gasserian ganglion block by the Härtel route; *b*, superior maxillary block by the Matas route.

Besides these three points, which are meant only to guide the needle toward the infratemporal plane, a fourth point, the articular tubercle of the zygoma, serves to direct the needle into the foramen ovale.

Technic.—The patient lies on his back and the operator stands on

the side to be injected. Both patient and operator face each other. With an applicator moistened with tincture of iodin, or with a sterile dermographic pencil, the midpoint of the zygomatic arch and the articular tubercle of the zygoma are traced on the skin. At about 3 cm. lateral to and a little above the angle of the mouth a wheal is raised, marking the level of the second upper molar tooth. The patient

Fig. 30.—Gasserian ganglion block. Position of the hands and direction of the needle toward the midpoint of the zygoma (¼).

is then asked to look straight before him. Needle No. 4 (10 cm.) is introduced through the wheal, along the line of intersection of two planes, one of which passes through the site of puncture of the needle and the pupil of the eye of the patient, and the other through the same site of puncture and the midpoint of the zygoma, on the same side (Fig. 30), in such a way that, when facing the patient, the needle is

Fig. 31.—Gasserian ganglion block. Direction of the needle in the plane passing through the pupil.

Fig. 32.—Gasserian ganglion block: 1, Direction of needle toward the midpoint of the zygoma; 2, direction of needle toward the articular tubercle of the zygoma.

directed toward his pupil (Fig. 31) and, when looking laterally, it is directed toward the midpoint of the zygoma (Fig. 32). The forefinger, placed in the mouth, serves as a guide and prevents the point of the needle from going through the mucosa of the cheek. In its progression from the skin the needle passes beneath the mucous membrane medial to the buccinator muscle, between the ascending ramus of the lower jaw and the tuberosity of the maxilla, and through the pterygoid muscles.

Fig. 33.—Gasserian ganglion block. Directions of the needle shown in relation to the skull.

At a depth of about 5 cm. the point of the needle strikes against the smooth infratemporal plane, in front of the foramen ovale. Its direction is upward, inward, and backward. The hub of the needle is then raised so that its point aims at the articular tubercle of the zygoma, care being exercised to keep the needle in the plane passing through the pupil of the patient (Fig. 33). Contact of the infratemporal plane is soon lost and the needle, being introduced from 1 to 1.5 cm.

deeper, passes behind the infratemporal plane into the foramen ovale, after coming in contact with the third branch of the trigeminus. Paresthesias or radiating sensations in the lower jaw immediately follow, thus indicating that the needle is in its correct place. Sometimes the point of the needle is felt passing through a membrane stretched in front of the foramen before any paresthesias are obtained. In such cases the foramen is very wide, the nerve passing at its lower part, leaving a free space for the needle above it. In case there is no certainty as to whether or not the point of the needle has passed through the foramen ovale, after it has lost contact with the infratemporal plane, the needle advancing without inducing paresthesias, it is advisable not to go further than 1.5 cm. The needle might be going astray through one of the other foramina, for instance, through the foramen spinosum, through which the middle meningeal artery passes, and thus enter the cranial cavity.

It is safer not to inject before making sure that the point of the needle is really within the capsule of the gasserian ganglion, because the capsule might have been pierced by the point of the needle without any paresthesias being obtained. To make sure that the needle has passed through the foramen ovale, in case of a large foramen, it is necessary to incline the needle slightly downward and try to come in contact with the inferior and posterior wall of the foramen ovale, thus trying to get in touch with the mandibular nerve, which is the best guide toward the gasserian ganglion. After going through the foramen ovale the needle should not be introduced more than 1 cm. further. The flow of cerebrospinal fluid prompts the slight withdrawal of the needle until the flow ceases, since it is a proof that the point of the needle is beyond the ganglion, in the subarachnoid space.

Not more than 1 c.c. of the 2 per cent. solution should be injected for surgical purposes, and 1 c.c. of 85 per cent. alcohol for the relief of trifacial neuralgia. Injection should be very slow, drop by drop, without too great pressure. A small 2 c.c. Luer syringe should be preferred to the 10 c.c. regional anesthesia syringe. Injection of larger quantities, or of the same quantity made rapidly, has very frequently been accompanied by severe symptoms due to intracranial injection

or diffusion of the solution upward. In any case the anesthesia is immediate and extends to all three branches of the trigeminus. Alcohol injections are followed by a severe burning sensation in the whole territory of the fifth nerve; it is therefore recommended to inject 2 or 3 drops of a 5 per cent. novocain solution as soon as the ganglion has been located, starting the alcohol injection one or two minutes later, without changing the position of the needle. A greater quantity of novocain solution would only serve to dilute the alcohol and render the injection less effective.

Indications.—The gasserian ganglion block is indicated in the treatment of severe trifacial neuralgia and for extensive operations on the face, such as resection of the maxilla or of the lower jaw. Novocain injections may be repeated several times in the treatment of trifacial neuralgia, and likewise alcohol injections; but the period of relief seems, in certain cases, to become shorter following each and every subsequent injection. There are occasionally severe complications incidental to the injection of the gasserian ganglion with novocain or alcohol, especially the latter, and one should know how to avoid them and be familiar with their treatment before any attempt is made to inject the ganglion. Novocain injections of the ganglion are advised as a test for trifacial neuralgia. Alcohol injections should be repeated several times before resecting the posterior root of the gasserian ganglion. If the injections do not always give permanent relief, there is usually improvement during a comparatively long time (three to fourteen months). The extensive anesthesia thus obtained in the whole territory of the trigeminus serves besides to educate the patient to a similar condition of numbness which will set in after the radical treatment of his neuralgia.

Complications.—Hemorrhage in the cheek occasionally happens, but has no importance, if the region has not been traumatized by repeated punctures, in attempting to reach the foramen ovale. Paralysis of the muscles of the eye, paresis of the abducens, of the masseter, and dropping of the lower jaw are transient. Vertigo, nausea, and vomiting will not appear if the patient is kept in the supine position for at least one hour after the injection. Patients never complain of masticatory

troubles; on the contrary, after the injection they are delighted to be able to eat and chew, a fact which Härtel was the first to observe. A few days after novocain or alcohol injections small herpetic blisters may appear at the angle of the mouth, and occasionally extend as far as the cheek and eyelids. This eruption is transient, lasting but a few days.

A more serious complication is neuroparalytic keratitis. Corneal ulcers, with partial loss of sight, due to external causes, such as trauma, desiccation, infection, dust, especially draft in train, compressory dressings, and so forth. These ulcers heal nicely under proper treatment, leaving occasionally but a small macula. Paresthesias are frequent, and sometimes so severe that one cannot speak of cure practically, although there is *objectively* absolute anesthesia.

Eye complications are more frequent in outdoor patients. It is therefore necessary to keep them in hospital for about ten or twelve days, during which they can be closely observed and taken care of. Proper protection of the eye should be made with a Buller's shield immediately after the injection. The shield is worn for a week or ten days, and subsequently exchanged for close-fitting automobile goggles (Härtel-Adson). Protective treatment should be accompanied by irrigations twice daily of a 2 per cent. boric acid solution. Härtel recommends the use of boric acid ungnent (boric acid 0.3, vaselin, pure white, 10). Slight inflammation prompts the use of atropin solution and instillation of 2 or 3 drops of argyrol (1 : 10) twice daily.

Orbital Block

(Blocking of the Branches of the Ophthalmic Nerve)

The *ophthalmic nerve* arises from the anterior margin of the gasserian ganglion, passes upward and forward in the lateral wall of the cavernous sinus, and reaches the sphenoidal fissure, where it breaks up into its terminal branches, which pass through the fissure into the orbit. The ophthalmic nerve is not accessible at the base of the skull; but its branches are easily reached within the orbit or at their emergence from that cavity.

The *lacrimal nerve* lies lateral to the frontal nerve and passes through the outer angle of the sphenoidal fissure, following its course along the lateral wall of the orbit to the upper and lateral angle of the orbit, where it pierces the palpebral fascia and terminates in the upper eyelid. It supplies the lacrimal gland, the upper eyelid, and the skin around the external canthus. Within the orbit the lacrimal nerve anastomoses with the temporomalar nerve, a branch of the maxillary nerve.

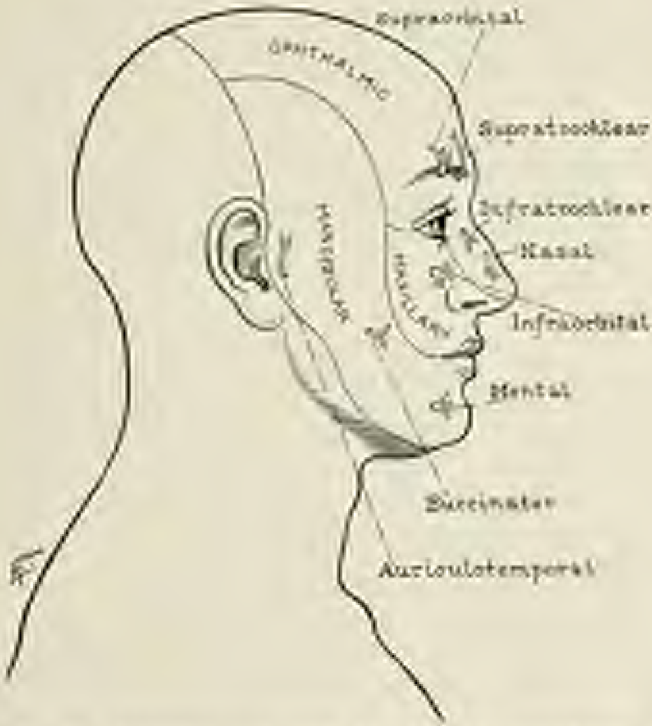

Fig. 34.—Distribution of sensory branches of trigeminal nerve.

The *frontal nerve* enters the orbit through the sphenoidal fissure above the orbital muscles and passes directly forward between the periosteum and the levator palpebræ superioris, where it divides into supratrochlear and supra-orbital nerves.

The *supratrochlear nerve* passes inward and forward over the pulley of the superior oblique muscle, leaves the orbit at its upper medial angle, and supplies the middle and lower part of the forehead. At the

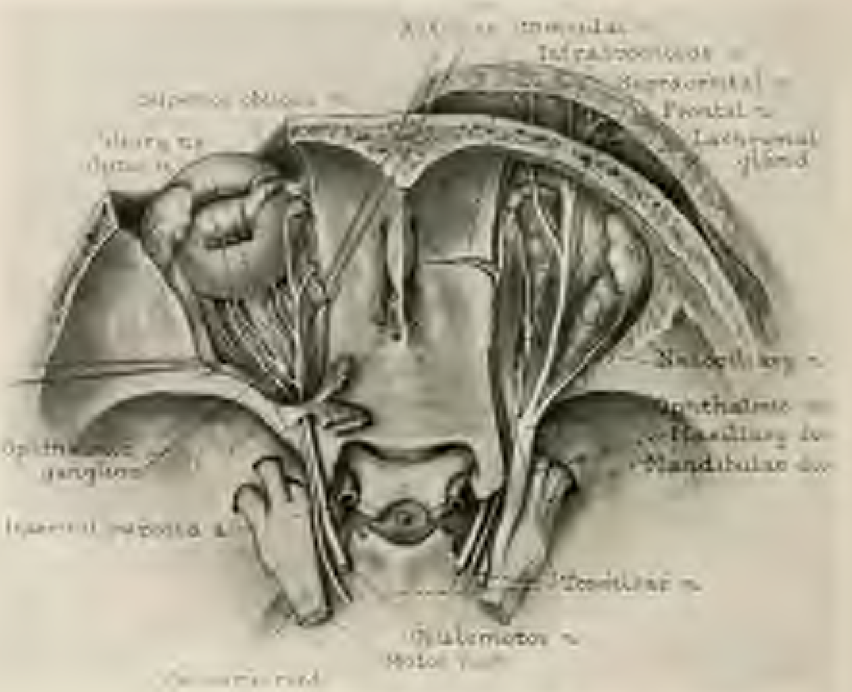

Fig. 35.—Divisions of the ophthalmic nerve.

Fig. 36.—Nerves of the orbit entering the right orbital cavity through the sphenoidal fissure.

margin of the orbit filaments are given off to the skin and conjunctiva of the upper eyelid.

The *supra-orbital nerve* continues the general course of the frontal nerve and leaves the orbit through the supra-orbital notch or foramen. It supplies the frontal sinus, the upper eyelid, and is distributed to the forehead, the scalp, and pericranium as far as the vertex.

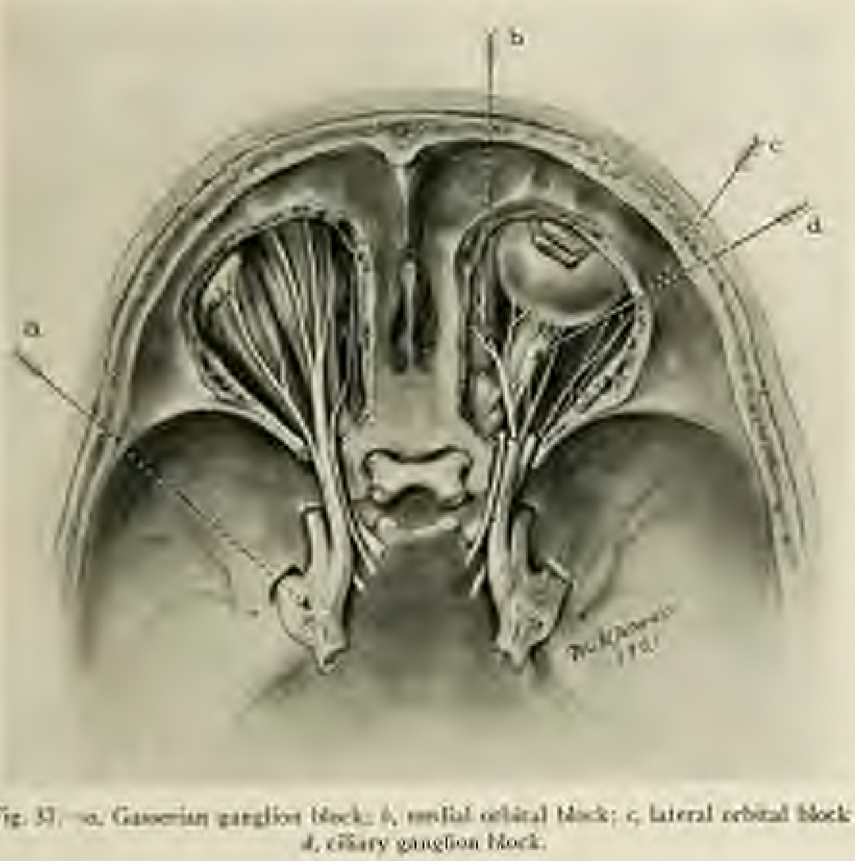

Fig. 37.—*a*, Gasserian ganglion block; *b*, medial orbital block; *c*, lateral orbital block; *d*, ciliary ganglion block.

The *nasociliary nerve* enters the orbit through the sphenoidal fissure, between the heads of the external rectus muscle, passes obliquely inward across the optic nerve, between the superior and internal recti muscles, reaches the anterior ethmoidal foramen, and enters the cranial cavity through that foramen under the name of anterior ethmoidal or nasal nerve.

The *nasal nerve*, continuing the course of the nasociliary nerve, leaves the cranium through the nasal fissure of the cribriform plate of the ethmoid bone, enters the nasal fossa and breaks up into its three terminal branches, the internal, external, and anterior nasal nerves. This last branch passes out of the nasal fossa at the union of the lower margin of the nasal bone and the nasal cartilage and supplies the skin of the forepart and tip of the nose. In the orbit the *nasociliary nerve* gives off a *ganglionic branch* to the ciliary ganglion, the *long ciliary*

Fig. 35.—Terminal branches of the ophthalmic nerve emerging from the orbital cavity and the infra-orbital nerve, contributing to the innervation of the eyelids and forehead.

branches, which are distributed to the iris, ciliary muscle, and cornea; the *posterior ethmoidal nerve*, which passes through the posterior ethmoidal foramen and is distributed to the ethmoidal cells and sphenoidal cavity; the *infratrochlear nerve*, which runs forward along the medial wall of the orbit, beneath the pulley of the superior oblique muscle, toward the inner canthus, where it terminates in supplying the skin of the forehead, the root of the nose, the inner part of the eyelids, the conjunctiva, and the lacrimal sac.

The topography of these nerves makes them easy of access either

along the medial wall of the orbit or at the sphenoidal fissure (Fig. 37). The frontal and lacrimal nerves are anesthetized by injections made at the sphenoidal fissure; but the nasociliary nerve is ordinarily blocked on the medial wall of the orbit. The terminal branches of the frontal nerve may be injected either at their emergence from the upper margin of the orbit or above the eyebrow (Fig. 38).

Fig. 39.—Frontal field block. Line of infiltration above the eyebrow; resulting zone of anesthesia.

Lateral Orbital Block.—The needle may be introduced either a little above the outer canthus (Braun route) (Fig. 40, *b*), or a little below it (Fig. 40, *c*), as frequently done by the author; but in both cases it must be inserted at the margin of the orbit, so as to facilitate its progression along the lateral wall, toward the sphenoidal fissure. If introduced above the canthus, final contact is taken above the fissure. If below, the injection is made at the lower part of the apex of the orbit, below the fissure. In both cases the point of the needle feels the

smooth surface of the lateral wall of the orbit and keeps constant contact with it until it has reached a depth of about 3.5 cm. The eyeball is retracted either downward or upward, according to the procedure used, by means of the tip of the forefinger of the left hand. Needle No. 2 (5 cm.) is the one ordinarily employed; but Duverger recommends the use of a needle 3.5 or 4 cm. long, so as not to have the tendency of going further than 3.5 cm. deep, thus avoiding the possible injury of the optic nerve in cases where it has to be preserved. Not more than 3 c.c. of the 2 per cent. novocain-adrenalin solution should be injected, so as to avoid too much protrusion of the eyeball. With

Fig. 40.—Orbital block: *a*, Medial orbital block: *b* and *c*, lateral orbital block. The margin of the orbit is shown by dotted lines.

some experience, any length of needle can be used. Hematomas seldom occur and cannot be avoided. This is of no clinical significance with a very fine needle.

Medial Orbital Block (Peuckert Route).—Vertically above the caruncle and a little below the eyebrow, that is to say, at about 1 cm. or one fingerbreadth above the inner canthus (Fig. 40, *a*), needle No. 2 is introduced along the upper medial angle of the orbit, keeping close contact with the bony surface, until a depth of about 3.5 cm. is reached; 2 c.c. of the 2 per cent. solution are then injected.

The medial orbital block is ordinarily associated with the lateral

orbital block for operations on the orbit. These injections anesthetize also the ethmoidal, sphenoidal, and frontal sinuses, part of the nasal cavity, the forepart and tip of the nose, the upper eyelid, the conjunctiva, and the lacrimal sac, as well as the muscles of the eye. The lower eyelid is but partly anesthetized because of the infra-orbital nerve supply. The great quantity of loose, diffluent, adipose tissue contained in the orbit facilitates the diffusion of the anesthetic solu-

Fig. 41.—Orbital block. Direction of needle in relation to skeleton: a, Medial orbital block; b, lateral orbital block by the inferior route (Fig. 40, c).

tion in such a way that it is impossible to confine the anesthesia to a part only of the nerve supply of the eye. These injections are, therefore, restricted to enucleation and exenteration of the eye, and to other extensive interventions on the orbital structures, as well as on the frontal, ethmoidal, and sphenoidal sinuses. The injection of the nasociliary nerve by the medial orbital block finds a more frequent application in operations on the lacrimal sac and the nose.

Maxillary Block

(Blocking of the Maxillary Nerve)

The maxillary nerve leaves the gasserian ganglion between the ophthalmic and mandibular nerves, passes through the foramen rotundum, traverses the sphenomaxillary fossa, and enters the orbital

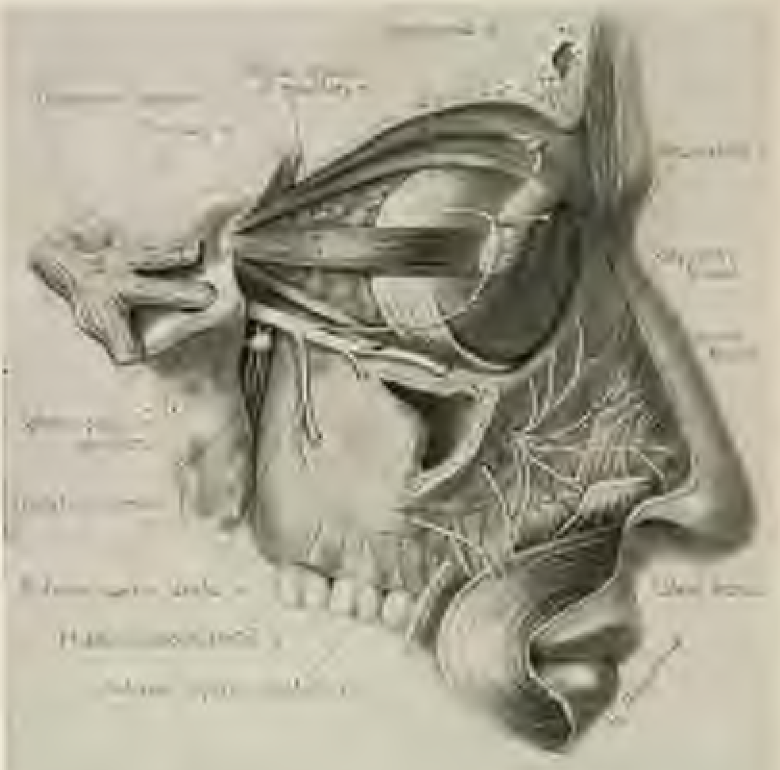

Fig. 42.—The maxillary nerve and its branches.

cavity through the sphenomaxillary fissure. It lies in the floor of the orbit in the infra-orbital groove and canal, and emerges through the infra-orbital foramen, where it breaks up fanwise into three terminal groups of branches (Fig. 42). Within the sphenomaxillary fossa the maxillary nerve gives off the sphenopalatine, the posterior and middle superior dental, and the temporomalar nerves; in the infra-orbital

groove, the middle (sometimes) and the anterior superior dental nerves. The infra-orbital nerve gives off the inferior palpebral, lateral nasal, and superior labial branches.

The maxillary nerve supplies the cheek, lower eyelid, side of the nose, upper lip, upper teeth, mucous membrane of the nose, nasopharynx, antrum, posterior ethmoidal cells, soft palate, tonsils, and roof of the mouth.

Fig. 43.—Maxillary block by the extra-oral—zygomatic route (1).

The maxillary nerve may be anesthetized at the foramen rotundum by the orbital route, as proposed by Matas, or in the sphenomaxillary fossa by the lateral or zygomatic route, as described by Schlösser and others. It may also be reached through the mouth either by passing the needle laterally to the tuberosity of the maxilla, or behind the last upper molar tooth. Two routes of approach are, therefore, available: the *oral* and the *extra-oral*. In dentistry, preference is given to the oral route, while in general surgery this route is restricted to cases where the extra-oral route is rendered difficult owing to serious changes in the

anatomic features of the region. The sphenopalatine or Meckel's ganglion lies just beneath the maxillary nerve, in the maxillary fossa, so that blocking the maxillary nerve means blocking the ganglion and its efferent branches, the palatine nerves.

Extra-oral—Zygomatic Route.—There are two ways of approaching the maxillary nerve in the maxillary fossa by the lateral or zygomatic route:

Fig. 44.—Maxillary block. Direction of needle in relation to skeleton: 1 takes contact with pterygoid process; 2 aims at foramen rotundum; 3 aims at foramen ovale and illustrates the possibility of injecting both maxillary and mandibular nerves from a single point of entrance (page 96).

1. By introducing the needle immediately below the lower border of the zygoma, through the sigmoid notch, at the midpoint of the zygomatic arch (Schlösser). Needle No. 3 (8 cm.) is introduced deeply in a transverse direction, a little upward, toward the pterygoid process, and the depth at which the needle takes contact with this bone is recorded by a small piece of rubber or cork previously threaded on the needle (Braun). The needle is then withdrawn until its point reaches the subcutaneous tissue, so as to change its direction, and is

reintroduced inclined a little frontward toward the sphenomaxillary fossa (Fig. 44). When the recorder reaches the skin surface it marks the depth at which the point of the needle had struck the pterygoid process. If no bony contact is now obtained, the needle is introduced very slowly 0.5 cm. further and injection of 2 c.c. of the 2 per cent. novocain solution made at that point. If the needle again strikes the bone, it should be partially withdrawn and reintroduced in a direction

Fig. 45.—Maxillary block by the extra-oral—zygomatic route (2).

a little more inclined upward and frontward. In case of alcohol injection, the nerve must be located before injection is commenced. Paresthesias in the upper jaw, or teeth, indicate that the nerve has been hit, in which case the anesthesia is almost immediate. For surgical purposes it is not necessary to make intraneural injections, since they are occasionally followed by severe pain lasting several days and even weeks. Injection into the sphenomaxillary fossa of large quantities of fluid are likely to be followed by exophthalmos, edema of the eyelids,

and at the same time anesthesia of the ophthalmic nerve, conditions which are not desirable.

2. By introducing the needle in the angle formed by the anterior border of the coronoid process of the ascending ramus of the mandible with the lower margin of the malar bone (Schlösser route) (Fig. 45). Needle No. 3 (8 cm.) is introduced transversely and directed a little upward toward the tuberosity of the maxilla; after taking contact with

Fig. 46.—Maxillary block by the orbital route. The needle in the vertical position takes contact with the floor of the orbit before being shifted to the horizontal in the direction of the arrow.

the bone, it is withdrawn a little so as to change its direction, and reintroduced slightly inclined backward until it is felt entering the sphenomaxillary fossa, immediately after losing contact of the maxilla, at about 5 or 6 cm. from the skin surface. The general direction of the needle is then upward, backward, and inward toward the apex of the orbit. If paresthesias are obtained in the territory of the sphenopalatine ganglion the injection is made without going any further.

since the maxillary nerve lies close to it; 2 c.c. of the 2 per cent. solution are then injected after making sure that the point of the needle does not lie in the lumen of the internal maxillary artery. Hematomas of the cheek are not infrequent.

It is sometimes necessary to ask the patient to open the mouth so that the needle may be introduced in the right direction. These are cases in which the coronoid process is very wide and greatly overlaps the entrance to the sphenomaxillary fossa.

Extra-oral—Orbital Route.—Needle No. 3 (8 cm.) is introduced on the lateral part of the lower margin of the orbit, close to its inferior

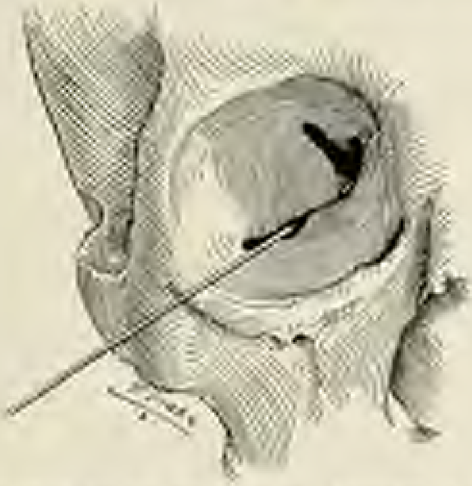

Fig. 47.—Maxillary block by the orbital route. Direction of needle in relation to skeleton.

lateral angle, and is directed vertically downward to meet the floor of the orbit. As soon as this is reached the shaft of the needle is swung vertically downward to the horizontal plane passing through the site of puncture (Fig. 46). It is then advanced slowly and gently in the direction of the apex of the orbital cavity, keeping close contact with the floor of the orbit until it passes through the fissure giving access to the sphenomaxillary fossa, then to the foramen rotundum, which it reaches at an average depth of from 4.5 to 5 cm. (Fig. 47). As soon as paresthesias are obtained, injection is made of 2 c.c. of the 2 per cent. solution.

If the direction of the needle is not carefully observed the needle passes into the temporal fossa or into the orbital fat and the injection serves no purpose. Hematomas are frequent. Occasional paralysis of the muscles of the eye is transient.

Oral Route.—There are two ways of blocking the maxillary nerve by the oral route:

1. With a retractor, or the forefinger of the left hand placed at the angle of the mouth, the cheek is well retracted upward and backward, and

Fig. 48.—Maxillary block by the oral route (I).

the needle inserted in the mucous reflection above the first upper molar tooth. The needle is then advanced in a direction backward, upward, and inward, tangent to the tuberosity of the maxilla, and making with the sagittal plane of the head an angle of about 40 degrees. The point of the needle loses contact with the bony surface at a distance of from 3 to 4 cm. from its point of entrance. It is then introduced 0.5 cm. farther, and injection of 2 c.c. of the 2 per cent. solution made slowly (Figs. 48 and 49).

2. With a needle bent to an angle of 145 degrees, or with a straight needle connected with the syringe by a curved adjustment, the maxillary nerve may be blocked by introducing the needle behind the last upper molar tooth and directing it upward and a little inward, almost perpendicularly to the triturating surface of the teeth (Fig. 50). The needle passes laterally in the angle formed by the tuberosity of the

Fig. 49.—Maxillary block by the oral route (I). Direction of needle (a) in relation to skeleton.

maxilla and the pterygoid process and at a depth of from 3.5 to 4 cm. reaches the sphenomaxillary fossa, where 2 c.c. of the 2 per cent. solution are injected slowly.

Paresthesias obtained in the territory of the palatine nerves indicate that the point of the needle is in the correct direction. Injection may then be started while the needle is advanced about 0.5 cm. further, in the same direction, toward the maxillary nerve. The palatine gang-

lion may be blocked the same way, although it will not be necessary to go deeper than 3 cm. from the site of puncture.

Fig. 50.—Maxillary block by the oral route (2).

The first procedure is easier than the second, and is the one ordinarily employed in dental surgery; but one should be familiar with both procedures, so as to be able to use either of them in case of need.

Superior Posterior Dental Block

(Blocking of the Superior Posterior Dental Nerves)

The superior posterior dental nerves enter the posterior dental canals on the zygomatic aspect of the tuberosity of the maxilla and supply the molar teeth. They also contribute with the superior middle and anterior dental nerves to form the superior dental plexus (Fig. 51). They are easily blocked by distributing the solution (2 c.c. of the 2 per cent.) on the surface of the maxilla. The injection is made either through the mouth, by puncturing the mucous reflection at the level of the first molar tooth and directing the needle upward, inward, and backward, keeping it in close contact with the maxilla (Fig. 52); or by

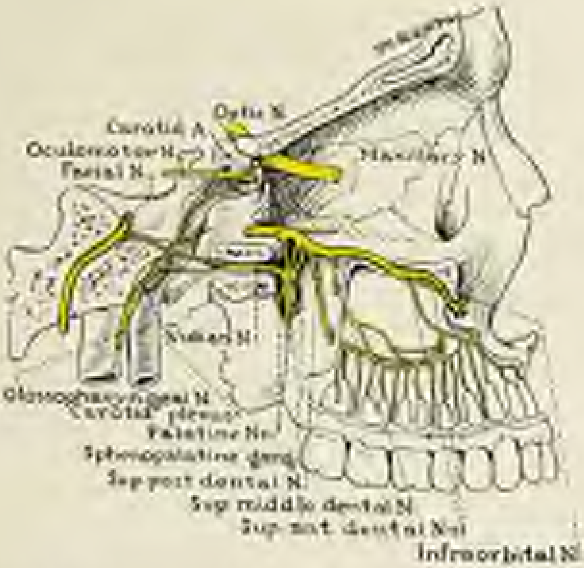

Fig. 51.—Superior posterior dental block. Formation of superior dental plexus.

Fig. 52.—Superior posterior dental block. Procedure similar to the maxillary block.

following the lateral route, introducing the needle on the lower border of the malar portion of the zygomatic arch and directing it transversely to meet the surface of the maxilla (Fig. 53). No paresthesias are necessary; but the fluid must be injected close to the bone. The average depth to which the needle is introduced is from 2 to 3 cm. by the oral route, and from 3 to 4 cm. by the lateral or zygomatic route. In dentistry preference is given to the oral route.

Fig. 53.—Superior posterior dental block by the extra-oral route.

These injections block at the same time the superior middle dental nerve, when this nerve is given off in the sphenomaxillary fossa and enters the maxilla close to the superior posterior dental nerves. They are indicated in interventions on the molar teeth and bicuspids; but they should be combined with the posterior palatine block so as to insensitize the gum on the medial aspect of the teeth.

Palatine Block

(Blocking of the Palatine Nerves)

The palatine nerves originate from the sphenopalatine or Meckel's ganglion (Fig. 54):

(*a*) The *anterior palatine nerve* passes through the posterior palatine or pterygopalatine canal and descends almost vertically into the oral cavity, where it emerges from the posterior palatine foramen. It then runs forward on the hard palate, giving off numerous branches which

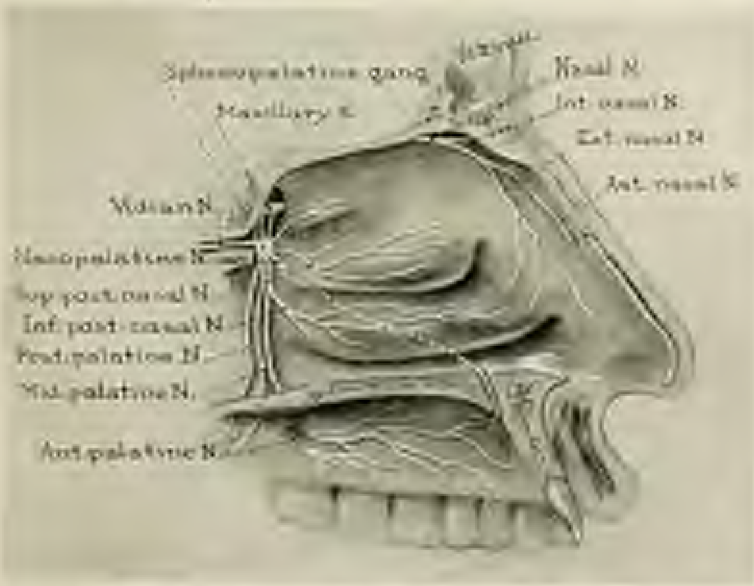

Fig. 54.—The sphenopalatine ganglion and palatine nerves.

inosculate with the terminal branches of the nasopalatine nerve (Fig. 55). It supplies the posterior half of the hard palate and its mucous membrane. In the palatine canal the anterior palatine nerve gives off branches to the mucous membrane of the turbinates, except the anterior portion of the inferior turbinate.

(*b*) The *posterior palatine nerves* run parallel to the anterior palatine nerve and supply the mucous membrane of the soft palate and the tonsil.

(*c*) The *nasopalatine nerve* enters the nasal fossa through the

sphenopalatine foramen, runs obliquely downward and forward in a groove in the vomer and septal cartilage, passes through the anterior palatine canal and reaches the hard palate, where it anastomoses with the anterior palatine nerve. It supplies the roof and septum of the nose, and the anterior half of the hard palate, including their mucous membrane.

The anterior palatine canals very often converge into one single foramen. The posterior palatine canal is situated at the level of the last molar tooth, about 1 cm. medial to it.

The **anterior palatine block** of the nasopalatine nerve is realized by inserting the needle behind the central incisor tooth, at the base of the

Fig. 55.—Palatine block. View of the hard palate with resection of the mucous membrane on the right showing nerve supply.

gum (about 0.5 cm. from the midline), and injecting 1 c.c. of the 2 per cent. solution.

The **posterior palatine block** of the anterior palatine nerve is performed by introducing the needle through a point of the palate 1 cm. opposite the second molar. This point is approximately equidistant between the gingival margin and the midline. The needle is directed slightly backward and upward, and 1 c.c. of the 2 per cent. solution is injected very slowly. A larger amount of fluid extends the anesthesia to the soft palate, and the combined edema and anesthesia thus produced bring about a nauseated condition which might be mistaken for toxic symptoms due to the injection. The sensation is that of a

mass stuck in the nasopharynx, which can neither be swallowed nor thrown out, despite all efforts to do so. The distress is such as to lead to faintness in nervous individuals. This is the author's experience after a superior posterior dental block and a posterior palatine block had been done on him. This condition does not last very long; but the alarming character it assumes during that short period is sufficiently suggestive. Care should, therefore, be exercised to inject slowly not more than 1 c.c. of the solution.

INFRA-ORBITAL BLOCK

(Blocking of the Infra-orbital Nerve)

The infra-orbital nerve spreads out fanwise immediately after its exit from the infra-orbital foramen, dividing into three sets of branches (Fig. 56):

Fig. 56.—The infra-orbital nerve.

(a) *Inferior palpebral branches*, supplying the conjunctiva and skin of the lower eyelid.

(b) *Lateral nasal branches*, supplying the skin of the side of the nose.

(*c*) *Superior labial branches*, supplying the anterior portion of the skin of the cheek, the mucous membrane and skin of the upper lip.

The infra-orbital foramen is situated at about 0.5 cm. below the midpoint of the lower margin of the orbit and at about 2.5 cm. from the midline of the face. A straight line drawn through the infra-orbital foramen, passing through the supra-orbital notch, or foramen, passes also through the mental foramen; and this line likewise marks the second bicuspid, although it occasionally passes between the first and second (Figs. 57 and 58).

Fig. 57.—The supra-orbital, infra-orbital, and mental nerves at their exits from their respective foramina.

The infra-orbital foramen gives access to the infra-orbital canal, which is directed obliquely backward and upward, making an angle of about 45 degrees with the floor of the orbit. The infra-orbital canal is from 1 to 1.5 cm. long; it communicates with the orbital cavity, and is continued backward by the infra-orbital groove, carved in the floor of that cavity and in which lies the maxillary nerve. It is, therefore, clear that a needle introduced more than 1 cm. into the canal will reach the contents of the orbit, and, according to the depth to which it is introduced, cause damage to some of its structures (Fig. 59).

It occasionally happens that the infra-orbital canal communicates with the antrum of Highmore and is entirely independent of the orbit.

In such cases the maxillary nerve passes through the maxilla just beneath the roof of the antrum (Fig. 60), an anatomic disposition which

Fig. 59.—Relation of the supra-orbital, infra-orbital, and mental foramina to one another and to the midline as illustrated by the line *A–B* drawn parallel to the midline and at 2.5 cm. from it.

undoubtedly predisposes to neuritis, but does not interfere with the technic of the regional block.

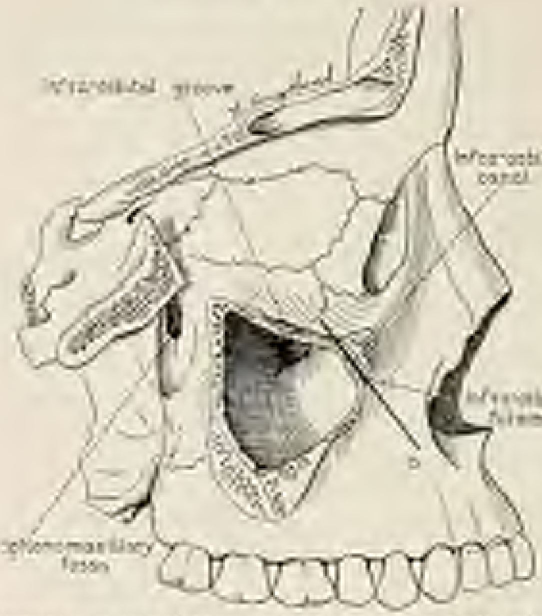

Fig. 39.—Sagittal section of the maxilla through the right infra-orbital foramen and canal, showing the direction of the canal and its relation to the orbital cavity: *a* is a probe introduced into the infra-orbital canal.

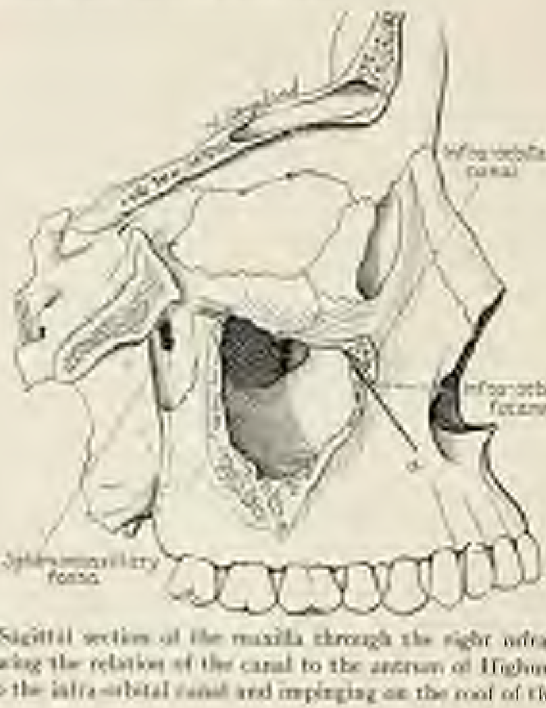

Fig. 40.—Sagittal section of the maxilla through the right infra-orbital foramen and canal, showing the relation of the canal to the antrum of Highmore: *a* is a probe introduced into the infra-orbital canal and impinging on the roof of the antrum.

The infra-orbital nerve may be blocked either through the mouth or from outside.

Oral Route.—The upper lip is retracted with the thumb of the left hand, while the index-finger of the same hand is held on the infra-orbital foramen previously located. Needle No. 2 (5 cm.), previously

Fig. 61.—Infra-orbital block by the oral route. The needle is introduced at the apex of the first bicuspid and directed upward, backward, and outward toward the palpating finger.

attached to the syringe, is introduced through the mucous reflection at the level of the apex of the first bicuspid and directed upward, backward, and outward along the maxilla, toward the palpating finger (Fig. 61). The injection of a few drops of the anesthetic fluid, while the needle advances, renders the manipulation almost painless. As

soon as the point of the needle is felt entering the foramen injection is made of 2 c.c. of the 2 per cent. solution and the region submitted to a little massage.

Extra-oral Route.—The needle is introduced through the cheek 1 cm. below the midpoint of the lower margin of the orbit and 1 c.c. of

Fig. 62.—Infra-orbital block by the extra-oral route. The needle is introduced 1 cm. below the midpoint of the lower margin of the orbit and directed upward and a little backward toward the infra-orbital foramen.

the 2 per cent. solution injected as soon as the needle reaches the bone, so as to render the subsequent maneuvers painless. The infra-orbital foramen is searched for by directing the needle a little backward and upward; as soon as the point of the needle is felt entering the infra-

orbital canal 2 c.c. of the same solution are injected and the region lightly massaged (Fig. 62). The syringe is ordinarily held like a penholder while the needle is introduced. The intradermal wheal needle may be

Fig. 63.—Infra-orbital block: *B* shows direction of needle by the oral route; *A* is a probe passed through the infra-orbital canal into the orbital cavity, showing how easy it is sometimes for the needle to enter that cavity if poor technic is used.

used; but care should be exercised not to introduce it as far as the hub, since it occasionally breaks at that point.

The infra-orbital block is indicated in operations on the upper lip and lower eyelid. When operating on the upper lip bilateral blocking is necessary. The lower eyelid is besides supplied by the infratrochlear

and the temporomalar nerves, so that these nerves must likewise be blocked in order to obtain a complete anesthesia of the eyelid. To obviate the difficulty, field-block is resorted to, as described on page 145. Deep injections into the infra-orbital canal are indicated when

Fig. 64.—Infra-orbital block. Resulting zone of anesthesia after bilateral block.

operating on the superior bicuspids, canines and incisors, and also in the treatment of trifacial neuralgia in its early stage.

Mandibular Block

(Blocking of the Mandibular Nerve)

The mandibular or inferior maxillary nerve is the third branch of the trigeminus and is a mixed nerve. Its sensory component arises from the lateral and anterior portion of the gasserian ganglion and is joined by the motor root, with which it is intimately associated on reaching the foramen ovale. The mandibular nerve leaves the cranial cavity through the foramen ovale, and after a course of from 2 to 3 mm. divides into its various branches, of which the most important

in connection with nerve-block are the inferior dental and the lingual (Fig. 65).

Besides a recurrent filament bringing in its contribution to the sensory innervation of the dura mater, the branches of the mandibular

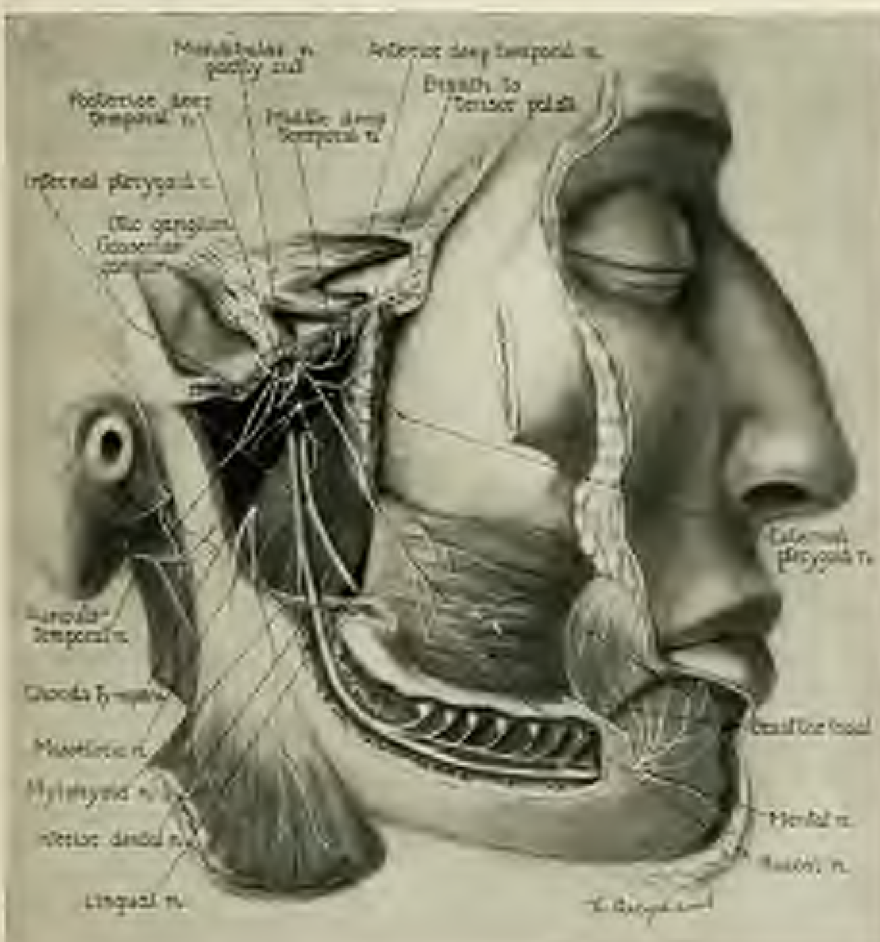

Fig. 65.—The mandibular nerve and its branches.

nerve are: the internal pterygoid, external pterygoid, masseteric, deep temporal, buccal, auriculotemporal (which gives off the articular, parotid, meatal, anterior auricular, and superficial temporal), lingual, and inferior dental.

The mandibular nerve supplies the temporal region, including the skull and the dura mater at the base of the skull, the temporomandibular joint, the auricle of the ear, the external auditory meatus, the lower portion of the face, the lower lip, the mucous membrane of the mouth, the tongue, the mandible, the lower teeth and gums, the salivary glands, and all the muscles of the lower jaw.

The mandibular nerve may be blocked by using either the oral or the extra-oral route:

Oral Route.—The cheek is retracted upward and backward, so as to disclose the second upper molar tooth. The needle is inserted in the mucous reflection above that tooth and directed backward and upward toward the midpoint of the zygoma, in a plane passing through the outer canthus and the site of puncture. At a depth of from 4 to 5 cm. the point of the needle reaches the mandibular nerve or takes contact with the infratemporal plane, just in front of the foramen ovale. If paresthesias are obtained, especially in the lower teeth or tongue, 2 c.c. of the 2 per cent. solution are injected; but if the bone is felt without any paresthesias, the needle should be drawn back a little and slightly changed in direction sideways. The needle should not aim at a point backward of or lower than the tubercle of the zygoma, since it might enter the foramen spinosum. As soon as radiating sensations are obtained in the territory of one of the branches of the mandibular nerve 2 c.c. of the 2 per cent. solution are injected slowly and gently; but these radiating sensations are not indispensable for surgical purposes, although they are immediately followed by anesthesia.

Extra-oral Route.—1. The Härtel route for the gasserian ganglion block (page 57) may be followed: the needle is introduced lateral to the angle of the mouth, at the level of the second upper molar tooth and directed backward, inward, and upward, passing beneath the mucous membrane of the cheek, between the ascending ramus and the tuberosity of the maxilla (Fig. 66). When facing the patient the needle is directed toward the pupil of the eye on the same side, and when looking laterally, it aims at the midpoint of the zygoma on the same side. As soon as paresthesias are obtained in the territory of the lower jaw 2 c.c. of the 2 per cent. solution are injected without trying

to reach or pass through the foramen ovale. Sometimes radiations are obtained in the ear. This is sufficient to warrant the injection without going any further, when surgical anesthesia is contemplated; but in the treatment of trifacial neuralgia the mandibular nerve itself should be injected at its exit from the foramen ovale.

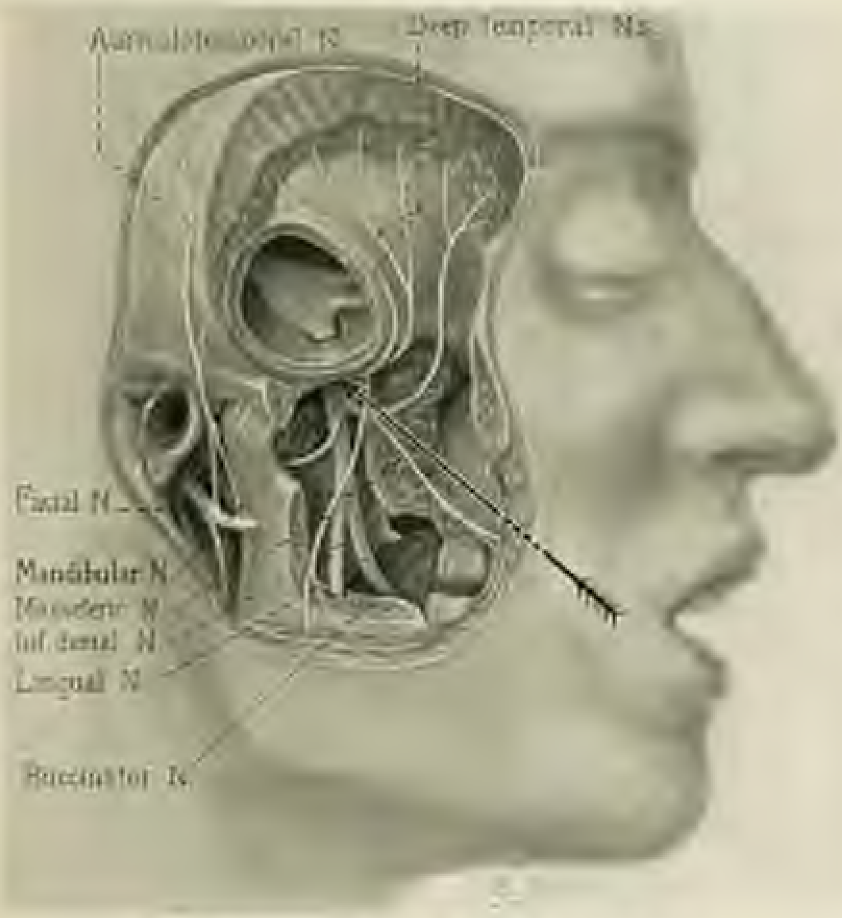

Fig. 66.—Mandibular block by the extra-oral route (1).

2. Needle No. 3 (8 cm.) is inserted immediately below the midpoint of the zygomatic arch and introduced transversely through the soft tissues (Fig. 67) until it reaches the pterygoid process of the sphenoid bone, at about 5 cm. from its point of entrance. The recorder with which the needle has previously been provided is brought in contact

Fig. 67.—Mandibular block by the extraoral route (2).

Fig. 68.—Mandibular block by the extraoral route (2). The needle (in dotted lines) impinges on the pterygoid process, is withdrawn a little, aiming in the direction of the arrow, and reintroduced toward the foramen ovale.

with the skin surface as soon as the bone is felt. The needle is then drawn back a little and reintroduced, aiming at about 1 cm. behind the point at which it first impinged on the pterygoid process, until the

Fig. 69.—Compasses of Offerhaus. Determination of the intertubercular line CD in Fig. 70. (After Braun.)

recorder reaches the surface of the skin (Fig. 68). If no paresthesias are obtained at that point, the needle is advanced 0.5 cm. deeper before injecting.

The use of a depth recorder in the shape of a small piece of rubber,

or cork, threaded on the needle, as first proposed by Braun, is a simple, easy, and rapid procedure, almost as accurate as the Offerhaus caliper method (Figs. 69 and 70).

When making intraneural injections of the mandibular nerve, either by the oral or extra-oral route, it frequently happens that the solution diffuses up to the gasserian ganglion, thus anesthetizing the whole area supplied by the trigeminus. Anesthesia of the cornea in such cases

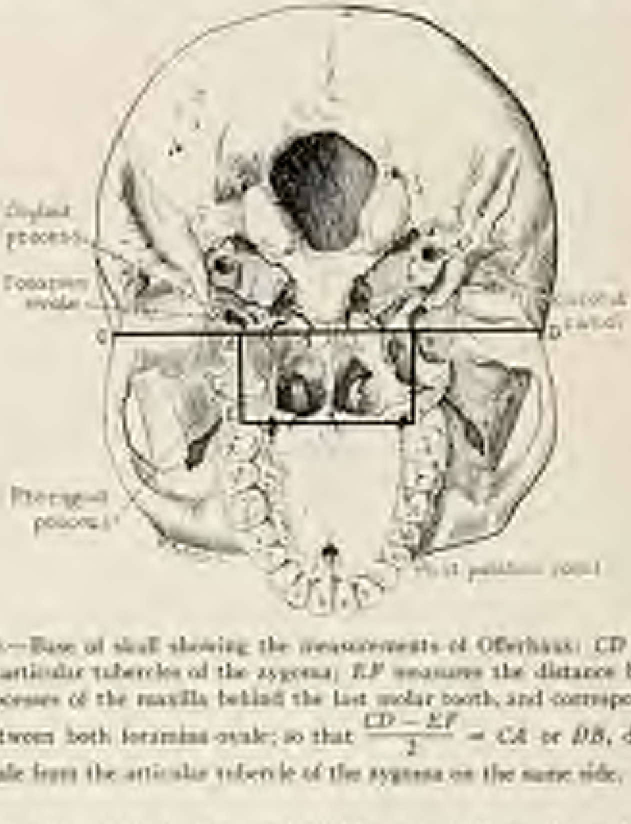

Fig. 70.—Base of skull showing the measurements of Offerhaus: CD is the line joining the articular tubercles of the zygoma; EF measures the distance between the alveolar processes of the maxilla behind the last molar tooth, and corresponds to AB, distance between both foramina ovale; so that $\frac{CD - EF}{2} = CA$ or DB, depth of the foramen ovale from the articular tubercle of the zygoma on the same side.

obtains rapidly, and is the undeniable proof that the solution has reached the gasserian ganglion. It is not a complication and has no clinical significance, provided the cornea is protected during the period of anesthesia (page 63).

The mandibular block is indicated chiefly in extensive operations on the lower jaw and parotid region, and in the treatment of trifacial neuralgia.

INFERIOR DENTAL BLOCK

(Blocking of the Inferior Dental Nerve)

On leaving the mandibular nerve, the inferior dental nerve lies posterior and lateral to the lingual nerve. It runs downward and forward to the inferior dental foramen, behind the lingula (spine of Spix), on the medial aspect of the ascending ramus of the mandible, enters the canal and continues its course within the bone until it reaches the mental foramen, where it emerges as the mental nerve,

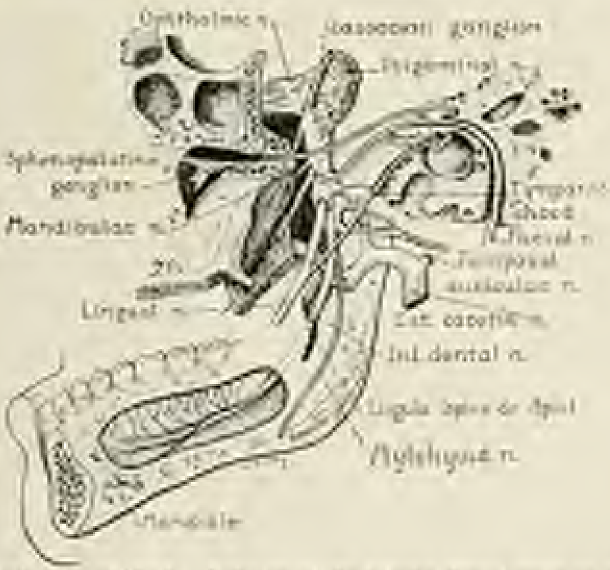

Fig. 71.—Inferior dental block. Relation of the inferior dental nerve to the ascending ramus and lingula. Inferior dental plexus.

breaking up fanwise into its terminal branches. Before entering the inferior dental canal the inferior dental nerve sends off branches to the mylohyoid muscle and to the anterior belly of the digastric muscle, and filaments to the oral mucosa and periosteum. During its course through the inferior dental canal it gives off numerous branches which inosculate to form the inferior dental plexus, supplying twigs to the molars and bicuspids. On reaching the mental foramen the inferior dental nerve gives off the incisor nerve, which continues its course within the mandible to the midline, supplying the canine and incisor teeth.

The mental nerve supplies the skin and integument and mucous membrane of the lower lip; it overlaps the midline just like all the other symmetric nerves of the body.

The anatomy of the mandible should be studied very closely before any attempt is made to block the inferior dental and lingual nerves. When facing the bone in its natural position (Fig. 72), and considering the ascending ramus on either side, one can see behind the last molar tooth a smooth triangular surface, the retromolar trigone (Braun),

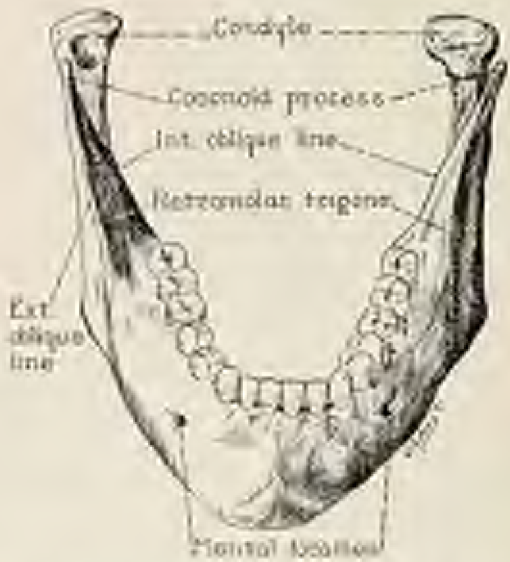

Fig. 72.—Front view of the mandible, with special reference to the retromolar trigone and medial aspect of the ascending ramus.

bounded on each side by the external and internal oblique lines. The external oblique line forms the anterior edge of the ascending ramus and is in the majority of cases sharp, while the internal oblique line is very often blunt and smooth. The retromolar trigone lies a little outward of the general direction of the lateral aspect of the dental arch. The medial aspect of the ascending ramus is hidden by the retromolar trigone when facing the mandible; but when looking at the bone a little laterally it is seen to be in the plane passing through the space between the central incisors, sometimes through the canine on the opposite side;

and one can easily see the lingula (spine of Spix) which overlaps the inferior dental foramen at the entrance of the inferior dental canal.

When facing the medial aspect of the ascending ramus (Fig. 73) we find that the lingula, which is our landmark, is situated on the line

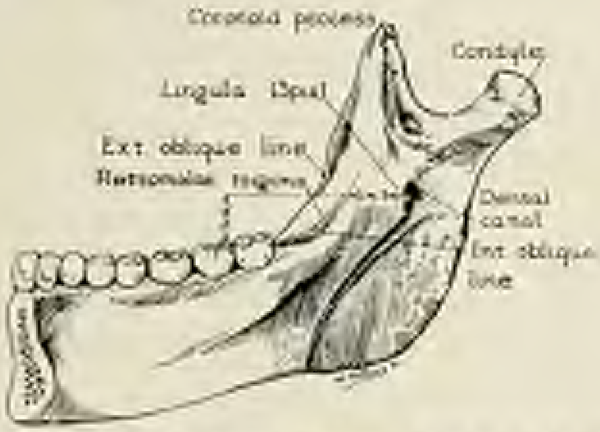

Fig. 73.—Medial aspect of the ascending ramus. Relation of the inferior dental foramen to the internal oblique line and triturating surface of the molar teeth.

joining the angle of the mandible to the coronoid process, midway between the two, and that it is also midway between the internal oblique line and the posterior margin of the ascending ramus. In measuring

Fig. 74.—Mandible of a child eight years of age. Note the level of the inferior dental foramen and the direction of the needle.

distances, so as to have an idea of the depth to which the needle should be introduced, we find that, in the average cases of adult bone, the inferior dental foramen, or the lingula, is situated at about 1.5 cm. backward of the internal oblique line, and if a line be drawn tangent to

the triturating surface of the molar teeth, the lingula is 1 cm. above that line.

The shape of the mandible changes while the bone develops from childhood to adult life; its angle being first obtuse, and progressively

Fig. 75.—Mandible of an adolescent eighteen years of age.

approaching a right angle, which is the normal condition in grown-up people. In children of about seven or eight years of age the inferior dental foramen is almost level with the molar teeth (Fig. 74). In

Fig. 76.—Mandible in old age. Note the level of the inferior dental foramen.

adolescents of from sixteen to eighteen years of age it is a little higher (Fig. 75); in the adult it is situated at about 1 cm. above the triturating surface of the molars. In old age the resorption of the alveolar process and the subsequent loss of teeth have a tendency to restore to the

mandible the shape it had in childhood, with this difference, that, owing to lack of teeth, the lingula is situated very high above the margin of the mandible (Fig. 76).

The inferior dental nerve may be blocked either through the mouth or from outside from a point of entrance situated at the level of the angle of the jaw.

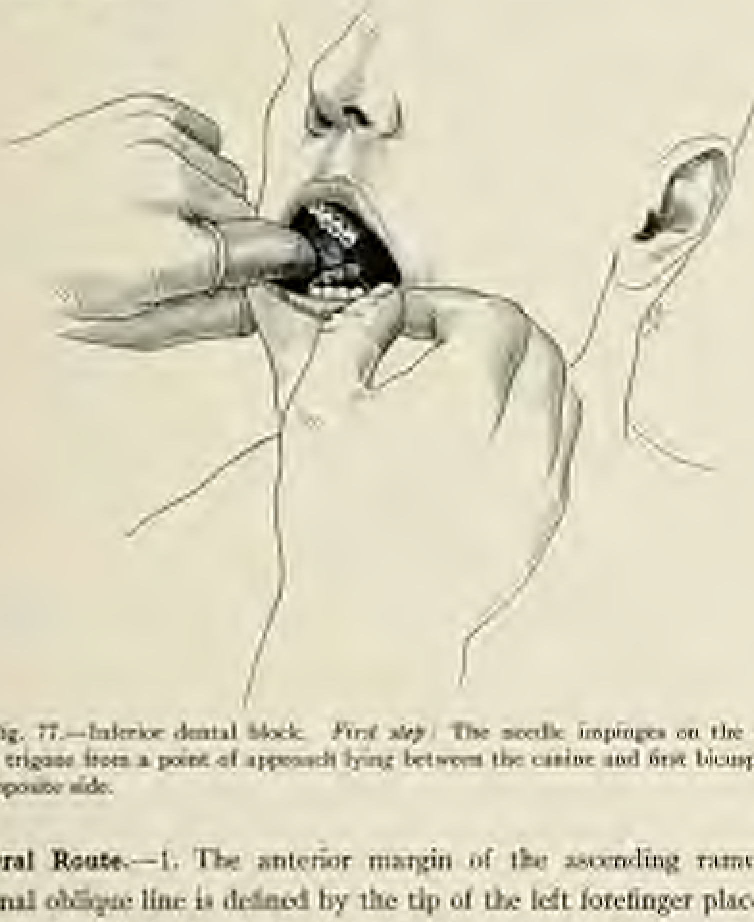

Fig. 77.—Inferior dental block. *First step:* The needle impinges on the retromolar trigone from a point of approach lying between the canine and first bicuspid on the opposite side.

Oral Route.—1. The anterior margin of the ascending ramus or external oblique line is defined by the tip of the left forefinger placed in the mouth. With the shaft of the needle resting on the dental arch, between the canine and the first bicuspid on the opposite side, needle No. 4 (10 cm.) is advanced toward the palpating finger and introduced just medial to it and 1 cm. above the triturating surface of the last molar tooth (Fig. 77). It then comes in contact with the retromolar trigone. The needle is then swung horizontally from this position to a direction

parallel with the dental arch of the molars on the side of the puncture, and its hub raised 1 cm. above the teeth. The shaft of the needle thus becomes parallel to the triturating surface of the molars and lies lateral to the dental arch (Fig. 78). The needle is now introduced gently through the mucosa, gradually feeling the bone on its way backward. Soon after the bony contact is lost, thus indicating that the internal oblique line or inner side of the trigone is being passed. At that par-

Fig. 78.—Inferior dental block. *Second step:* The needle turns around the internal oblique line.

ticular instant the hub of the needle is gently displaced horizontally toward the midline, above the incisors, and the needle introduced from 1.5 to 2 cm. deeper (Fig. 79). Its point is then at the lingula, that is, in close proximity to the inferior dental nerve; 2 c. c. of the 2 per cent. solution are then injected, without trying to hit the nerve. Absolute anesthesia obtains from two to five minutes later.

The needle should not be introduced further than 2.5 cm. after it has passed the inner side of the retromolar trigone; neither should it be

forced into the fibrous tissue lining the medial aspect of the ascending ramus, nor introduced too far away from the bone. The most favorable condition for injecting the inferior dental nerve is that in which the needle lies tangent to the medial aspect of the ascending ramus of the mandible. If this condition is not realized when the needle has been displaced horizontally to the midline, the needle should be returned to its original position between the canine and bicuspid on the opposite

Fig. 79.—Inferior dental block. *Third step*: The needle advances along the medial aspect of the ascending ramus of the mandible toward the inferior dental foramen.

side, and introduced gently and gradually, feeling its way close to the bone.

The same technic holds good when using the dentists' syringe of the Luer type and the Schimmer needles (page 21). The syringe is then considered as a prolongtion of the needle; it is allowed to rest on the dental arch, since its radius is sufficient to raise the shaft of the needle about 1 cm. above the triturating surface of the molar teeth. Owing

to the gage of the Schimmer needles, care and gentleness should be exercised in shifting from 2 to 3 (Fig. 80), since the point of the needle, already engaged in dense tissues, might break. The needle can reach the lingula while it lies in position 1, provided it does not impinge on the retromolar trigone, but passes right away along the medial aspect of the ascending ramus. This technic gives very satisfactory results in the hands of many dentists.

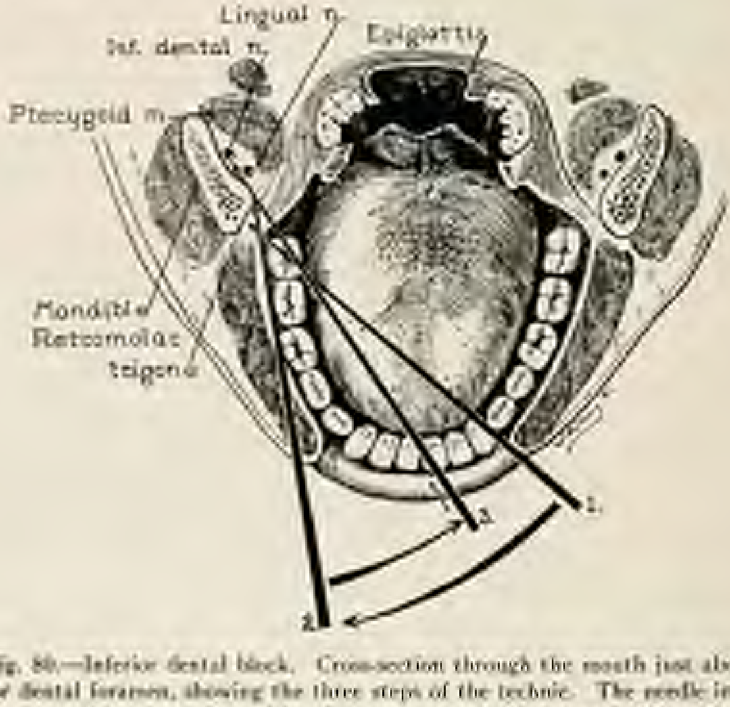

Fig. 80.—Inferior dental block. Cross-section through the mouth just above the inferior dental foramen, showing the three steps of the technic. The needle impinges on the retromolar trigone in position 1, passes around the internal oblique line after it has been swung to position 2, and advances along the medial aspect of the ascending ramus, toward the inferior dental and lingual nerves, while shifted from 2 to 3, or back to 1.

2. Needle No. 4 (10 cm.) is introduced about 1 cm. below the last upper molar tooth, a little lateral to the dental arch, and advanced 2 cm. backward along a line parallel to the arch; 2 c.c. of the 2 per cent. solution are then injected slowly, while the needle is moved slightly to and fro. The dentist's implements may also be used following the same technic.

Extra-oral Route.—The angle of the jaw is defined and marked by a wheal raised just a little below it. The tip of the forefinger of the left hand, placed in the depression of the sigmoid notch immediately below the zygomatic arch, defines the coronoid process in front of it. Half the distance between the wheal and the process is recorded by a small piece of rubber, or cork, threaded on needle No. 2. The needle is inserted through the wheal and advanced in an upward, inward, and frontward direction, along the medial aspect of the ascending ramus, toward the coronoid process (Fig. 81), until the recorder reaches the skin surface; 2 c.c. of the 2 per cent. solution are then injected,

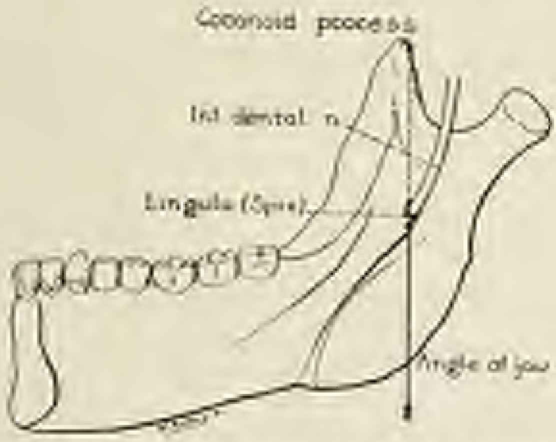

Fig. 81.—Inferior dental block by the extra-oral route. The arrow shows the direction of the needle in relation to the ascending ramus of the mandible.

while the needle is slightly moved to and fro. Here again it is advisable not to force the needle through the dense tissues overlying the bone, but to make it pass just tangent to these tissues.

The first procedure is very accurate and should be used when the lower molars are present. The second, in the hands of a trained man, is as accurate as the first, and is indicated when the upper molars are present. The last is of the highest value when all the molars are absent, and also in cases of trismus.

The inferior dental block is indicated for multiple extractions of teeth and all operations on the body of the mandible. When the operation involves the chin or lower lip bilateral block should be made, or

at least the dental block on one side and the mental block on the other, according to the operative field.

Lingual Block

(Blocking of the Lingual Nerve)

The lingual nerve lies medial and anterior to the inferior dental nerve, on the medial aspect of the ascending ramus. Thence it turns inward, forward, and downward, passes beneath the mucous membrane of the floor of the mouth, reaches the side of the tongue, and continues forward to its apex. It supplies the sublingual gland, the floor and side of the mouth, the side of the tongue, and the lower gum, as well as the submaxillary ganglion and the mucous membrane of the anterior two-thirds of the dorsum of the tongue (Fig. 128.)

The lingual nerve is blocked at the same time as the inferior dental nerve and by the same procedure (page 99).

The blocking of the lingual nerve is indicated in operations on the floor of the mouth and anterior half of the tongue.

Mental Block

(Blocking of the Mental Nerve)

The mental nerve is blocked at the mental foramen. The mental foramen is situated at about 2.5 cm. from the midline of the lower jaw, about midway between the margins of the mandible in the adult, a little nearer the lower margin in children, and a little closer to its upper margin in elderly patients. As already stated (page 86), a straight line drawn through the supra-orbital notch and infra-orbital foramen passes through the mental foramen. That line marks also the second bicuspid (Fig. 82). The mental foramen gives access to the mental canal which is directed frontward, downward, and inward, almost along the axis of the bone; so that, if it is desired to block the mental nerve within the canal, thereby blocking the incisor nerve at the same time, it will be necessary to insert the needle a little lateral to the foramen and introduce it along the axis of the canal, that is, frontward, inward,

and a little downward. The mental nerve may be blocked either through the mouth or from outside.

Oral Route.—With the teeth closed, the lower lip and angle of the mouth are retracted downward and backward with the forefinger of the left hand. Needle No. 2, fitted on to the syringe, is introduced in the

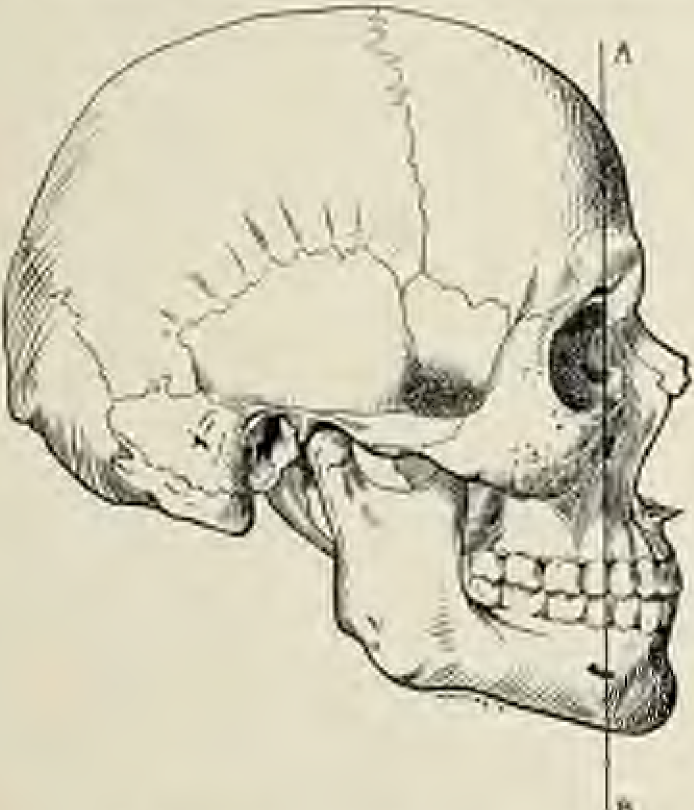

Fig. 82.—The straight line *AB* drawn through the supra-orbital notch and infra-orbital foramen passes through the mental foramen.

gingivobuccal reflection at the level of the space between the first and second bicuspids and advanced vertically downward close to the bone, as far as midway between the alveolar border and the lower margin of the mandible; 2 c.c. of the 2 per cent. solution are then injected and the region submitted to light massage (Figs. 83 and 85).

Extra-oral Route.—Needle No. 2, connected with the syringe, is

Fig. 83.—Mental block by the oral route.

Fig. 84.—Mental block by the extra-oral route. Note the direction of the needle.

introduced through a wheal raised midway between the gingival margin and the lower margin of the mandible, at a point 4 cm. lateral to the midline of the chin. It is directed frontward, inward, and downward, and advanced close to the bone and along its axis until its point is

Fig. 85.—Mental block: Arrow *A* shows the direction of the needle by the oral route; *B*, by the extra-oral route.

about 2.5 cm. from the midline (Figs. 84 and 85); 1 c.c. of the 2 per cent. solution is then injected before attempting to locate the mental foramen and pass the needle through it. Paresthesias are induced very frequently. As soon as the point of the needle is felt entering the foramen, 1 c.c. of the 2 per cent. solution is forced into the

canal. The incisor nerve is thus instantaneously blocked, and likewise the mental nerve. The solution diffuses also backward in the dental canal, although not far enough to block the nerve supply of the molar teeth.

The mental block is indicated for operations on the anterior portion of the lower jaw, including the chin, lower lip, mandible, bicuspids, cuspids, and incisors. When operating on the midline bilateral block is necessary. But in every case a subcutaneous infiltration along the lower border of the jaw is advisable, so as to block the superficial cervical nerves overlapping the operative field.

Superior Laryngeal Block

(Blocking of the Superior Laryngeal Nerve)

The superior laryngeal nerve arises from the inferior pole of the ganglion of the trunk or lower ganglion of the vagus and runs downward and inward beneath the external and internal carotid arteries, toward the superior cornu of the thyroid cartilage. A little below the great cornu of the hyoid bone, about 1 cm. in front of it, the nerve divides into (*a*) external and (*b*) internal laryngeal branches (Fig. 88 and 89).

(*a*) The *external laryngeal branch* passes downward upon the inferior constrictor of the pharynx and beneath the infrahyoid muscles, reaches the cricothyroid muscle, which it supplies, pierces the cricothyroid membrane nearly on the midline, and distributes its terminal filaments to the subglottic portion of the mucous membrane of the larynx and the ventricle. It gives off filaments to the inferior constrictor of the pharynx.

(*b*) The *internal laryngeal branch* passes downward and inward between the middle and inferior constrictors of the pharynx and enters the layrnx by piercing the thyrohyoid membrane. It supplies the mucous membrane of the base of the tongue, epiglottis, and larynx.

The superior laryngeal nerve is therefore accessible between the great cornu of the hyoid bone and the superior cornu of the thyroid cartilage.

Technic.—The patient may be in the sitting erect position, facing the operator, or in the recumbent dorsal position, with the head tilted a

little backward, so as to stretch moderately the soft structures of the anterior aspect of the neck. The great cornu on the side to be injected is rendered prominent by pressing with the left forefinger on the great cornu on the opposite side (Fig. 86). Needle No. 2 (5 cm.), unattached to the syringe, is introduced through a wheal raised 1 cm. below and 2 cm. in front of the extremity of the prominent cornu and advanced

Fig. 86.—Superior laryngeal block. The needle is inserted at a point 1 cm. below and 2 cm. in front of the extremity of the great cornu of the hyoid bone.

backward and slightly upward toward the cornu. The needle passes between the thyrohyoid muscle and the thyrohyoid membrane, and the nerve is gently sought for between the cornua of the hyoid bone and thyroid cartilage. The point of the needle must not be allowed to go beyond the line joining these cornua, which is the region of the blood-vessels. After making sure that no blood-vessel has been punctured, the

syringe is connected with the needle and injection made of 2 c.c. of the 2 per cent. solution. If paresthesias are induced, radiating toward the ear, the injection is made without moving. In the absence of paresthesias, half of the solution is injected below the cornu of the hyoid bone and the rest distributed while the needle is being withdrawn. During these manipulations the patient is urged not to speak nor swallow, but to signal any pain radiating toward the ear by raising his hand.

Fig. 87.—Inferior laryngeal block. The needle is inserted at the thyroid notch and follows the inner surface of the thyroid cartilage, obliquely downward, backward, and outward to the cricothyroid groove.

When blocking both the superior and inferior laryngeal nerves the needle may be passed through a single wheal raised on the midline at the thyroid notch (Figs. 88 and 89).

The superior laryngeal block is indicated for total laryngectomy and in the palliative treatment of tuberculous laryngitis. For therapeutic purposes alcoholic solutions of cocain are preferred to the novocain-

adrenalin solutions used for surgical anesthesia. The solution recommended by Canuyt gives entire satisfaction. It is composed of:

Cocain hydrochlorid..	10 cgm.
Alcohol (80 per cent.)..	10 c.c.

of which 2 c.c. are injected each time. The injections are made on both sides, if necessary, and may be repeated as often as required with-

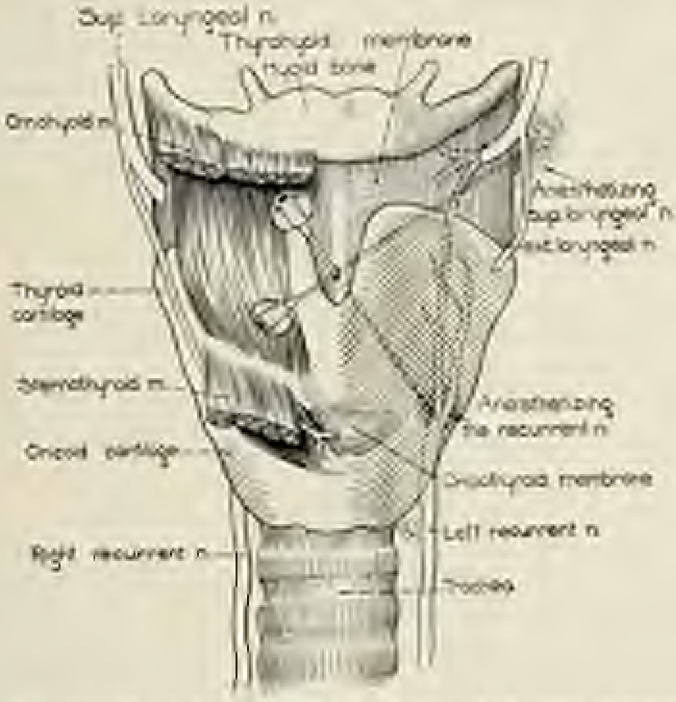

Fig. 88.—Superior and inferior laryngeal block from a single point of entrance at the thyroid notch. Front view.

out any ill-effects, provided the solution is fresh and pure. A warm solution is more active than a cold one.

Inferior or Recurrent Laryngeal Block

(Blocking of the Inferior or Recurrent Laryngeal Nerve)

The inferior or recurrent laryngeal nerve differs on the two sides in the early part of its course; but where the nerve becomes accessible

to the needle, its anatomic relations are identical on both sides. After returning to the neck, both recurrent nerves occupy the groove between the esophagus and trachea and enter the larynx at the lower margin of the cricoid cartilage, after dipping beneath or perforating the lower edge of the inferior constrictor of the pharynx (Fig. 89). They supply all the muscles of the larynx with the exception of the cricothyroid muscle.

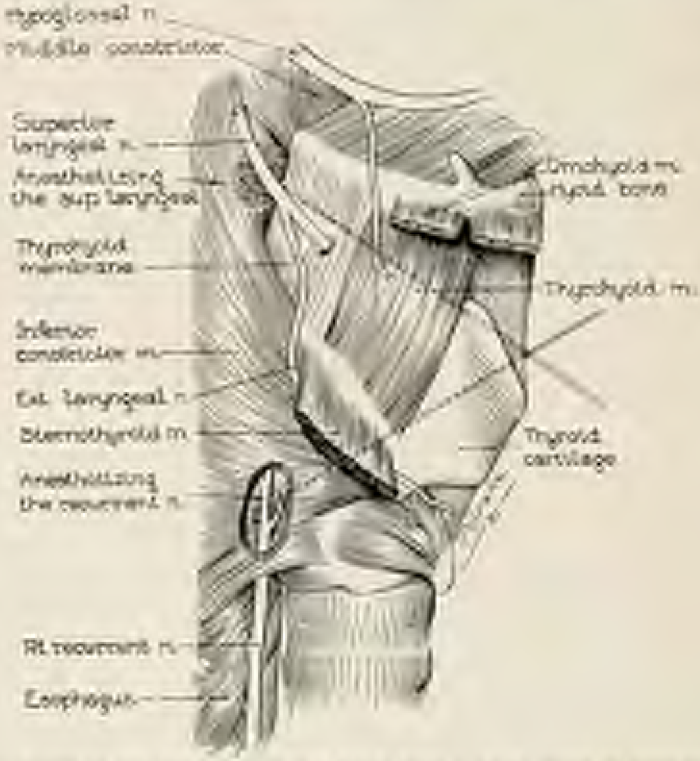

Fig. 89.—Superior and inferior laryngeal block from a single point of entrance at the thyroid notch. Side view.

Technic.—With the patient sitting erect or lying on his back, head tilted backward, the thyroid cartilage is held by the left hand, so that the tip of one of the fingers may lie on its inferior cornu and serve as a guide for the needle. Needle No. 2 (5 cm.), connected with the syringe, is introduced on the midline of the neck at the thyroid notch and advanced downward and backward toward the inferior cornu. A few drops of the solution are injected while the needle follows the inner

surface of the thyroid cartilage, beneath the mucosa, until the crico-thyroid groove is reached at the point where the finger marks the inferior cornu of the thyroid cartilage (Fig. 87). Paresthesias must not be sought for; but injection made of not more than 1 c.c. of the 2 per cent. solution without moving, as soon as the site of injection has been reached. The patient must neither move, speak, nor swallow during these manipulations.

The only indication of the inferior laryngeal block is for total laryngectomy by the first procedure (Fig. 228), that is, when no injections are made behind the larynx.

CHAPTER IV

OPERATIONS ON THE HEAD

Scalp and Cranium

The sensory innervation of the scalp and cranium is due to the trigeminal and cervical nerves. The forehead is supplied by the frontal nerve (supra-orbital and supratrochlear) and zygomaticotemporal or temporomalar nerve (second branch of the trigeminus); the temporal

Fig. 90.—Nerve supply of the scalp and cranium, with line of injection encircling the head.

region, by the temporomalar (second branch of the trigeminus) and the auriculotemporal (third branch of the trigeminus); the occipital and parietal regions, by the greater and lesser occipital nerves derived from the cervical nerves. These nerves become subfascial on a line encircling the head, drawn above the ear, and passing through the occiput and

glabella. They emerge from the fascia, become subcutaneous at different levels, very nearly the same in different individuals, and converge toward the vertex (Figs. 90 and 91).

It is, therefore, very easy to insensitize any portion of the scalp by making subcutaneous injections around the operative field, that is, by blocking the field, and this procedure not only anesthetizes the skin, fascia, pericranium, and cranium, but serves to control the blood-supply

Fig. 91.—Zone of anesthesia resulting from a line of infiltration encircling the head, passing through the occiput and glabella: *A–A'*, Subcutaneous and subfascial injections; *B*, deep injections close to the temporal bone, followed by subcutaneous infiltration.

of the operative area, inasmuch as the arteries follow the same radial direction as the nerves, and are favorably influenced by the adrenalin contained in the anesthetic solution. The various devices for stopping hemorrhage, such as Heidenhain's circumligation, Kredel's metal plates, or Vorschuetz's spring clamps, and so forth, are in the majority of cases superfluous. Although there is not always a completely dry field, the action of adrenalin being more apparent on the small vessels and capil-

laries, there is undoubtedly less bleeding, and it is hardly necessary to clamp any except the larger vessels. The smaller the anesthetized area, the greater the adrenalin anemia within it.

In those regions where the skull is covered by muscle layers, it is necessary to infiltrate these structures, so as to secure absolute anesthesia. Subperiosteal injections are superfluous; they serve no purpose.

The dura is only sensitive at the base of the skull; the brain, at least in the surgical regions, as well as the cerebellum and the dura of the posterior fossa, are free from pain on pressing, piercing, or cutting. Trephining of the skull for subtemporal decompression or ligation of middle meningeal artery, and so forth, is nowadays exceptionally performed under general anesthesia, since it is possible to operate under local or regional anesthesia or combine these methods with a first-stage general narcosis. But for more extensive operations, such as the resection of the posterior root of the fifth nerve or the excision of a cerebellar tumor, certain surgeons still prefer ether anesthesia, which, in abolishing consciousness, gives a better control of the patient.

The sensory innervation of the dura mater of the base of the skull is supplied by:

(*a*) The meningeal branch of the vagus which is distributed to the dura of the posterior fossa of the cranium, especially in the neighborhood of the lateral and occipital sinuses;

(*b*) The recurrent branch of the ophthalmic nerve distributed between the layers of the tentorium cerebelli;

(*c*) A recurrent branch given off by the maxillary nerve before it leaves the skull and supplying the middle cranial fossa;

(*d*) A recurrent branch of the mandibular nerve which accompanies the middle meningeal artery into the cranium through the foramen spinosum; it divides into two branches, the anterior of which supplies the greater wing of the sphenoid and the adjacent dura mater, while the posterior supplies the mucous membrane of the mastoid air-cells.

This knowledge leads us to the conclusion that, for operations involving the base of the skull and the adjacent dura mater, a more complete anesthesia is required and is obtained by blocking the gan-

serian ganglion. For instance, in the case of the resection of the posterior root of the trigeminus the gasserian ganglion block and subcutaneous infiltration around the operative field are all that is necessary; but for subtemporal decompression, removal of osteoplastic flaps, or cerebellar tumors, infiltration around the operative area is sufficient. The sinuses are anesthetized by local application of from 2 to 4 per cent. novocain-adrenalin solution in the course of the operation, or administration of a few whiffs of gas-oxygen, if the local procedures do not prove satisfactory.

The usual dose of morphin (0.01 gm. or $\frac{1}{6}$ gr.) and scopolamin (0.0002 gm. or $\frac{1}{300}$ gr.) is given one hour before the anesthesia is begun, just the same way as when dealing with other classes of patients; but the use of these drugs should be avoided in the case of brain injuries, or lesions causing intracranial pressure, more particularly in cerebellar tumors, owing to their action on the respiratory centers.

All bone instruments should be sharp, so as to avoid or rather lessen the unpleasant shock as much as possible. Undue hammering should consequently be avoided. In spite of these precautions and the extreme gentleness with which these patients are handled, some of them cannot help moaning all the time, although there is no actual pain, thus disturbing the quietude which the brain surgeon so urgently needs. The ideal method would be to induce local anesthesia and start the operation under light ether anesthesia, especially in those cases where the preliminary injection of narcotics does not seem to have had any real effect on the psychology of the patient. The analgesia thus produced is of the highest advantage both to the surgeon and the patient. Patients operated on with this combined method have a better and shorter convalescence.

Excision of sebaceous cysts and other minor superficial operations on the scalp are usually performed under field-block. Two wheals are raised, one at each extremity of the greater axis of the lesion, and through these wheals the needle is introduced in the direction of the extremities of the smaller axis (Fig. 92). The superficial fascia is infiltrated while the needle advances, the solution being distributed at a little distance from the lesion. If more than two wheals are necessary,

the solution is distributed along the lines joining these wheals (Fig. 93). One per cent. solution is used at the rate of 1 c.c. per 1 cm. of length of tissue.

Sutures of the Scalp.—Before scrubbing and disinfecting any wound of the scalp or cranium it is a good practice to begin with the anesthesia, so as to render all subsequent manipulations painless, unless the patient is comatose, as is frequently the case in fractures of the skull. A

Fig. 92.—Field-block for excision of small sebaceous cyst. The dots represent wheals through which the needle is introduced and advanced in the direction of the arrows.

narrow circular band is shaved around the wound, at about 2 inches from its periphery, and infiltration made along that band, the needle being introduced through as many wheals as are necessary to allow the straight needle to embrace the curvature of the skull. The superficial fascia is infiltrated with the 1 per cent. solution, using about 1 c.c. per 1 cm. of length of tissue. The muscle layers are also infiltrated, according to the situation of the wound (Fig. 94).

For extensive lateral sutures of the scalp a band of the scalp, about

Fig. 93.—Field-block for excision of large sebaceous cyst. The needle is inserted through wheals raised at points marked here by dots and advanced in the direction of the arrows.

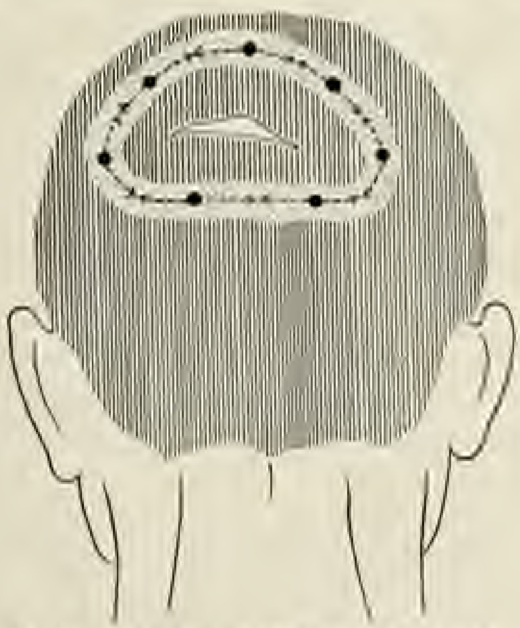

Fig. 94.—Field-block for small suture of the scalp.

1 inch wide, is shaved half-way around the head from the occiput to the forehead, passing above the ear, and another along the sagittal line (Fig. 95). Through one or more wheals raised immediately above the zygomatic arch deep injections are carried down to the bone, so as to reach the deep temporal nerves. Subcutaneous infiltration is made along the shaved band all around the operative field, subfascial injections being made wherever need be, that is, where muscle layers overlie

Fig. 95.—Field-block for extensive lateral sutures of the scalp, with or without fracture of the skull.

the cranium; 20 c.c. of the 1 per cent. solution are sufficient for the deep subtemporal injections and from 60 to 80 c.c. for the other circumferential injections.

If the wound lies on the vertex, overlapping the opposite side, the sagittal infiltration is not necessary, but bilateral injections should be made, similar and according to the procedure just described, thus anesthetizing the entire crown of the head, including the skull (Figs. 96 and 97).

Craniectomies.—According to the site of the lesion, unilateral or bilateral block is the ideal method for the surgical treatment of frac-

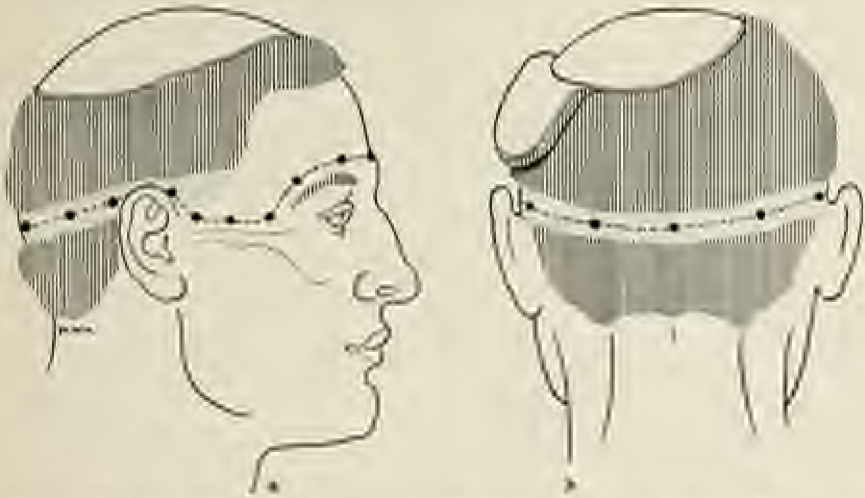

Fig. 96.—Field-block for extensive suture of the scalp overlapping the midline: *a*, *b*, Lateral and back views.

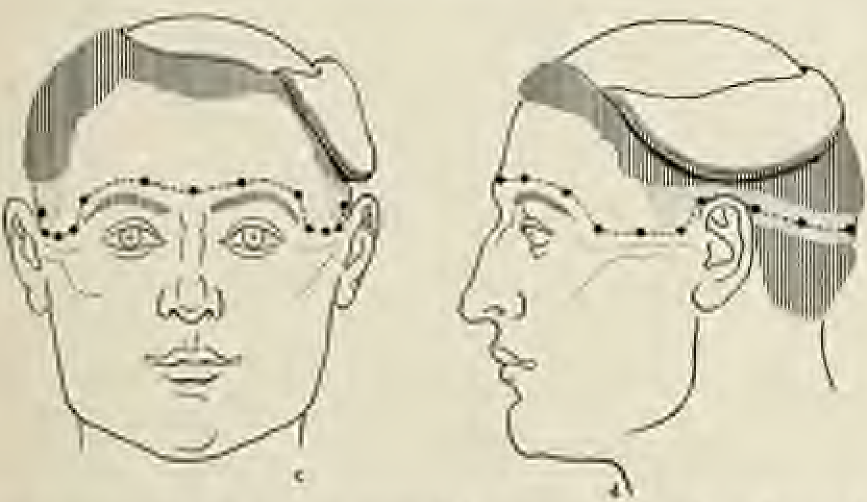

Fig. 97.—Field-block for extensive suture of the scalp overlapping the midline: *c*, *d*, Front and lateral views.

tures of the skull, extirpation of malignant growths, exploration or excision of intracranial tumors, subtemporal decompression, removal

of epidural hematoma, and ligation of middle meningeal artery (Figs. 98–100). The same anesthetic procedures described for sutures of the scalp are used for craniectomies.

Tumors of the Cerebellum.—The tissues overlying the occipital region and the upper part of the neck are anesthetized by circumferential infiltration. These parts are supplied by branches given off by the three first cervical nerves, which can be reached by carrying

Fig. 98.—Field-block for subtemporal decompression or ligation of the middle meningeal artery. Through 1 deep injections are made close to the skull, so as to reach the deep temporal nerves.

the injections close to the posterior aspect of the transverse processes of the two first cervical vertebræ and to the base of the skull, a little backward of the base of the mastoid process. The sensory nerves of the region are the greater occipital, lesser occipital, and posterior auricular nerves.

Figure 101 shows the area for injection, and the most convenient points for introducing the needle. Through 1, 2, 4, and 5 deep injections are made close to the base of the skull and the posterior aspect

Fig. 99.—Field-block for ligation of the middle meningeal artery. The cranium has been exposed and the points of trephining marked thereon: 1, Anterior branch; 2, posterior branch.

Fig. 100.—Points of trephining for hemorrhage from the middle meningeal artery.

of the transverse processes. Through 3 the soft tissues of the back of the neck are infiltrated as far as the spine, care being exercised not to enter the spinal canal. The needle is first introduced perpendicularly to the surface of the skin, then withdrawn until its point reaches the subcutaneous tissue, and reintroduced several times more and more obliquely, until its shaft lies beneath the skin. The solution is distributed while the needle is advanced as well as when it is withdrawn, thus creating a wall of anesthesia passing through 4, 3, and 5. All

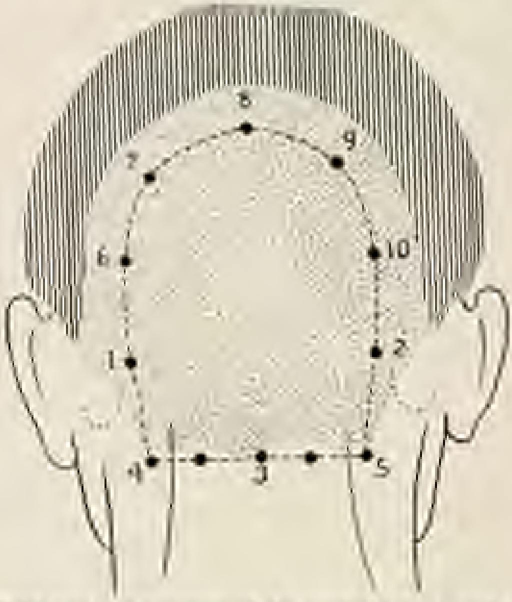

Fig. 101.—Field-block for exposure of the cerebellum: 1 and 2 are wheals raised just behind the base of the mastoid process; 4-3-5, along a horizontal line about two fingerbreadths below 1 and 2; 6-7-8-9-10, around and beyond the intended line of incision.

the wheals are finally joined together by subcutaneous and subfascial injections.

The quantity of solution used varies with the weight of the patient, that is, with the size of the head and neck; from 100 to 150 c.c. of the 0.5 per cent. solution being sufficient in the average cases.

The same procedure must be used if only one-half of the cerebellum is to be operated upon. If a wider field is required over the nape, the lateral rows of injections are prolonged downward so as to block a

greater number of cervical nerves. Painful parts of the dura, particularly those of the sinuses, are rendered insensitive by the application of thin bands of cotton moistened with 2 per cent. solution and maintained on the region for one or two minutes.

OPERATIONS ON THE FACE

The face derives its sensory nerve supply from the trigeminus, but the superficial cervical nerves most frequently overlap the territory of

Fig. 102.—Contrast of sensory territories of head and neck. The face and anterior part of the cranium (white area) is supplied by the trigeminal nerve. The gray zone is that of the cervical nerves. Note the encroachment of the cervical nerves on the lower jaw.

the trigeminus at the angle and along the lower border of the lower jaw (Fig. 102). Blocking the nerves on both sides by injecting the gasserian ganglion (page 57) and infiltrating subcutaneously along the lower border of the lower jaw gives, therefore, a complete anesthesia of the face and its cavities and the organs contained in them; but it is only in extensive operations on the maxilla that this procedure is resorted to. In the majority of cases it is sufficient to block the

terminal branches of the trigeminus and circuminject the operative field. The 1 per cent. novocain-adrenalin solution should be preferred to the 0.5 per cent. solution for circuminjection, because it can be used in smaller amounts. The injection of large quantities of fluid produces an unfavorable distortion of the anatomic features of the region. Adrenalin is of the highest value in such a vascular region of the body; but it should be used cautiously in plastic operations, so as not to reduce unnecessarily the vitality of the tissues. Half the usual dose (8 drops per 100 c.c.) is sufficient to give an almost completely dry field. Local infiltration, or field-blocking, should be preferred to nerve-blocking for the removal of moles, nevi, cysts, and so forth, that is, for the treatment of all superficial lesions or incision of abscesses; epitheliomata and carbuncles should be operated on by means of nerve-blocking, so as to avoid transplantation into or infection of healthy surrounding tissues.

When blocking an operative field it must be remembered that in certain regions of the face the principal innervation originates from the deep structures in the middle of the field. For instance, the infra-orbital and mental regions. Infiltration around the field does not give complete anesthesia; it is absolutely necessary to resort to nerve-block. If the nerve to be blocked emerges from its foramen, either beneath or in too close proximity to the lesion, blocking the nerve at a site of election remote from the operative field is a safe procedure. In case the lesion overlies the infra-orbital foramen, the superior maxillary nerve must be blocked by one of the lateral or zygomatic routes (page 72); if it interferes with the technic for the mental block, the inferior dental block must be resorted to. Operations on the middle of the chin require bilateral block of either the mental (page 108) or the inferior dental nerve (page 99), according to the extent of the lesion, associated with the infiltration of the cervical nerves along the lower border of the jaw.

OPERATIONS ON THE NOSE

Operations on the nose may be divided for the sake of regional anesthesia into two types: (1) Operations performed on the nasal

pyramid, involving at times its soft and cartilaginous parts, as in the case of rhinophyma, or extending to its bony structures and occasionally encroaching on the adjoining regions of the face, as in the case of carcinoma; (2) operations performed on the nasal cavities and their accessory sinuses, for sounding, drainage, curettage, resection, and so forth.

Fig. 103.—Sensory nerve supply of the exterior part of the nose.

The exterior part of the nose receives its innervation from the infratrochlear and external nasal nerves (branches of the ophthalmic nerve) and the infra-orbital (terminal branch of the maxillary nerve), as illustrated in Fig. 103.

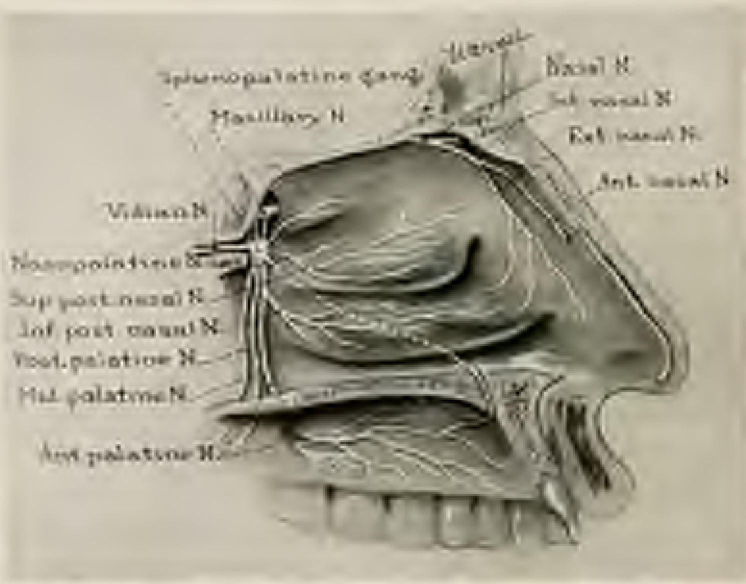

Fig. 104.—Sensory nerve supply of the nasal cavities (the lateral wall).

Fig. 105.—Sensory nerve supply of the nasal cavities (the septum).

The nasal cavities are supplied by the terminal branches of the anterior ethmoidal or nasal nerve (branch of the ophthalmic nerve)

and the posterior nasal and nasopalatine nerves, given off by the maxillary nerve through the palatine ganglion (Figs. 104 and 105).

The antrum of Highmore is innervated by the maxillary nerve alone; the frontal sinuses, by the anterior ethmoidal or nasal nerve and frontal nerve (branches of the ophthalmic nerve); the sphenoidal cavity and ethmoidal cells, by the maxillary and ethmoidal nerves.

Operations on the **tip of the nose** are easily performed by infiltrating the nasal pyramid in the manner suggested by Braun, Pauchet, and Sourdat: Three wheels are raised, one on the bridge of the nose at the

Fig. 106.—Field-block of the tip of the nose for rhinophyma.

junction of the bony and cartilaginous parts, and one on each side of the alæ of the nose. Through these wheals the soft tissues are infiltrated, as shown by the arrows in Fig. 106, injecting also beneath the attachment of the alæ and frenulum to the upper lip. Walls of anesthesia are thus created all around the operative field, blocking the nerve supply of the region. Ten to 15 c.c. of the 1 per cent. solution are sufficient. The anesthesia may be extended to the upper lip by injecting from 1 and 2 toward the angle of the mouth (Fig. 107), the solution being distributed submucously and subcutaneously. A finger placed in the mouth prevents the needle from piercing the mucosa. The

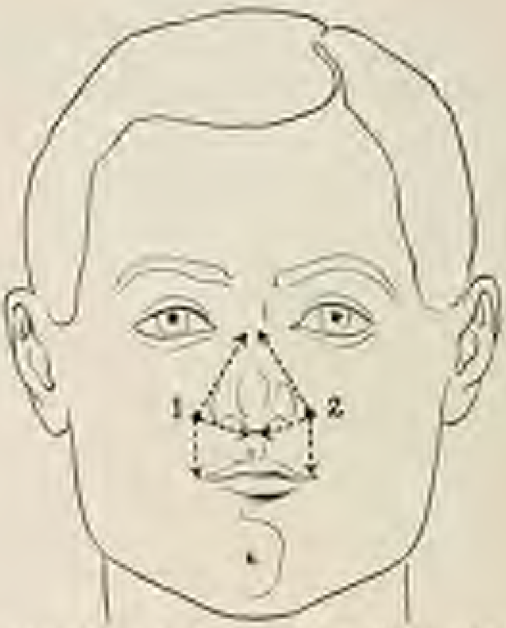

Fig. 107.—Field-block of the tip of the nose and upper lip: 1 and 2 are the only sites of puncture.

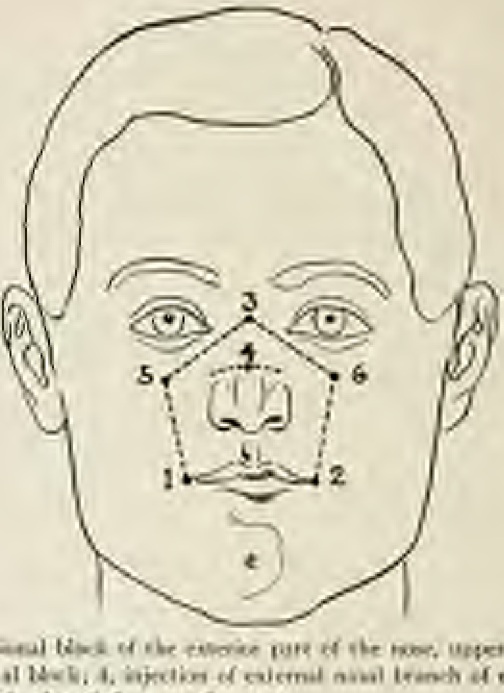

Fig. 108.—Regional block of the exterior part of the nose, upper lip, and cheeks: 5 and 6, Infra-orbital block; 4, injection of external nasal branch of ethmoidal nerve; 1-5-3-6-2, circuminjection of the operative area.

quantity of solution used should be such as to avoid too great distortion of the lip.

A wider zone of anesthesia is obtained by blocking the infra-orbital nerve at the infra-orbital foramen (page 85), and the branches of the nasociliary nerve (infratrochlear and ethmoidal nerves) by the medial

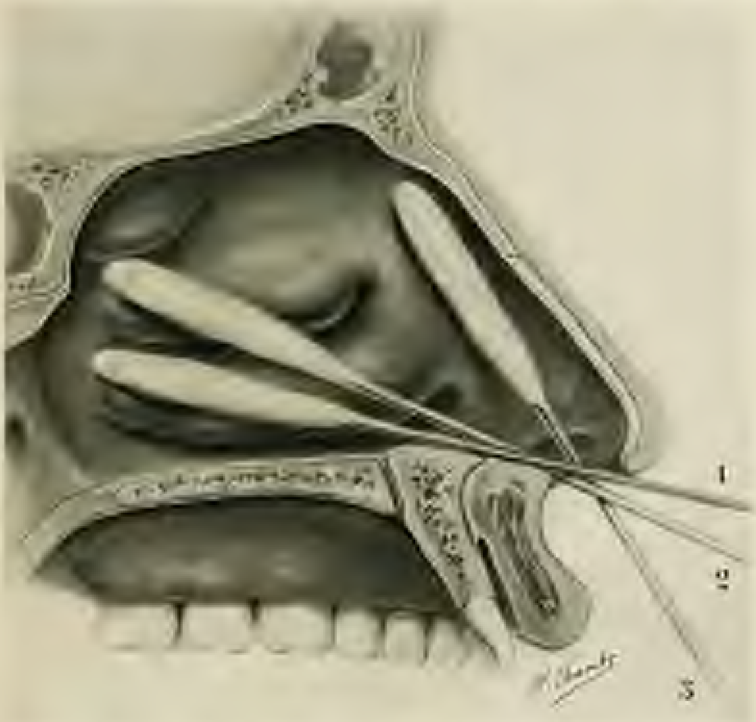

Fig. 109.—Intranasal block by means of applicators: 1 lies on the inferior posterior nasal nerve (lateral wall of the nasal cavity) and on the nasopalatine nerve (septum); 2 blocks the superior posterior nasal nerve; 3 takes care of the branches of the nasal or ethmoidal nerve.

orbital block (page 70). This procedure gives at the same time the anesthesia of the upper lip without supplementary injections.

For carcinoma of the skin and bony structures of the nose it is preferable to perform the maxillary block (page 72) and the medial orbital block (page 70) on both sides, so as to secure a wide anesthetic area which will be available in case of need.

The **resection of the septum** does not always necessitate the use

of nerve-blocking. An intranasal block is realized by means of applicators moistened with 10 per cent. novocain-adrenalin, or cocain, solution introduced in the manner shown in *Fig.* 109 and held in position for two or three minutes. A comparison of Figs. 110 and 111 shows clearly how the nerve supply of both walls is reached by the same applicator, and since the nerves lie immediately beneath the mucous membrane, the anesthesia is realized in a relatively short time; but this procedure is rendered difficult by the presence of spurs and deviations of the septum or other irregularities of the nasal cavity. Curved applicators

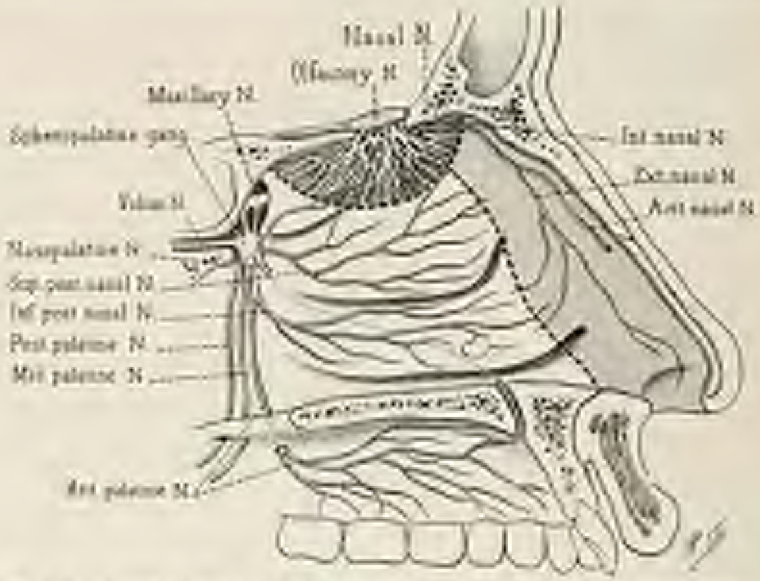

Fig. 110.—Areas of nerve distribution on the lateral wall of the nasal cavity.

are very useful in those cases. Applications are renewed if necessary. Cocain solution gives more rapid anesthesia, but it must be used cautiously. The patient, as advised by Bresgens (Braun), is asked to "bend his head sharply forward so that the anesthetic does not run into the throat, he is also at the same time directed to blow the side of the nose which has been anesthetized, the opposite half of the nose being closed." Cocain has also the advantage of enlarging the nasal cavities by contracting its blood-vessels and, consequently, its mucous lining; but the addition of adrenalin to novocain solutions is satisfactory if

time is allowed. Submucous injections on both sides of the septum are frequently necessary to produce absolute anesthesia of its bony and cartilaginous structures.

The Killian method of regional anesthesia of the nasal cavity (Fig. 111) will be resorted to when the presence of scar tissue, occasionally found in the septal mucosa, is likely to interfere with the production of complete anesthesia by the application method.

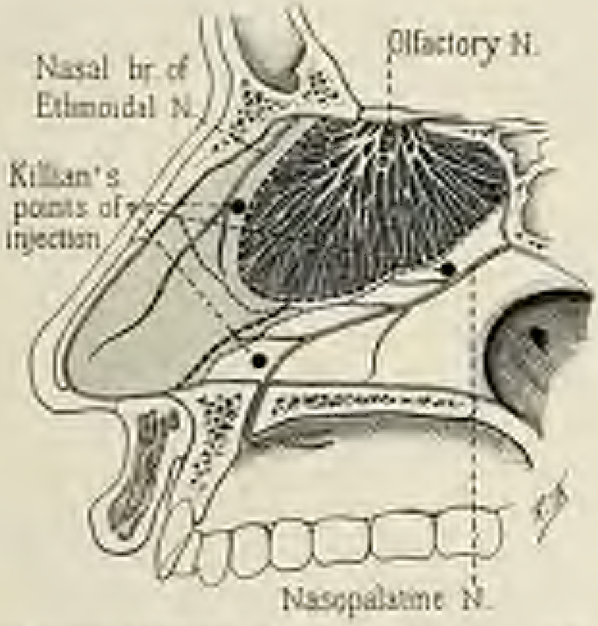

Fig. 111.—Areas of nerve distribution on the septum of the nose. Killian's points of injection.

If it is necessary to connect the frontal sinuses or posterior ethmoidal cells with the nose, it is preferable to apply the maxillary block (page 72) associated with the medial orbital block (page 70), which procedure holds good in case of partial or total obstruction of the nasal cavities.

Operations on the **turbinates** are also performed by local swabbing of the mucous membrane, care being exercised to control, by means of curved applicators, the entire surface of the septum in case of irregularities, such as spurs and deviations.

Operations on the **antrum of Highmore** require the maxillary block (page 72). Extensive operations for chronic empyema are thus painlessly performed; simple sounding or drainage of the antrum through the nasal cavity only needs swabbing of the mucous membrane with a 10 per cent. novocain-adrenalin, or cocain, solution. If the operation involes the antrum, ethmoidal, sphenoidal, and frontal sinuses complete anesthesia of these cavities will be realized by a bilateral maxillary block (page 72) and a bilateral medial orbital block (page 70).

OPERATIONS ON THE FRONTAL SINUSES

Radical operations for empyema of the frontal sinuses, such as the Killian, Ogston-Luc, or Moure operation, are painlessly per-

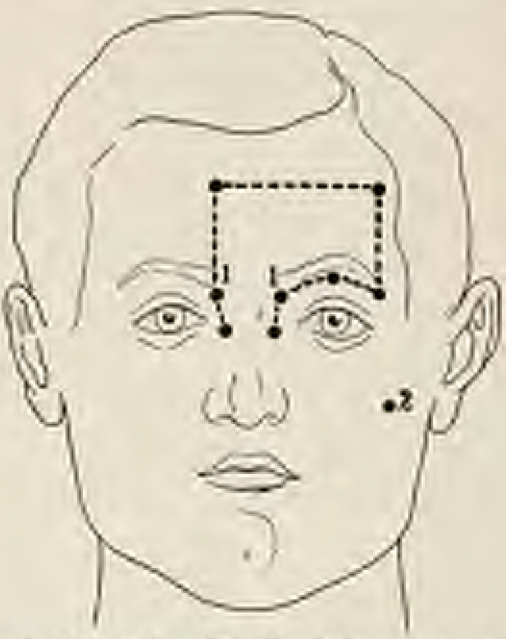

Fig. 112.—Regional block for unilateral radical operation on the frontal sinus: 1, Medial orbital block; 2, maxillary block. The dotted lines indicate the limits of the field-block.

formed after a bilateral medial orbital block (page 70) and maxillary block (page 72), associated with the injection of the frontal nerve above the bulb, done in the following manner: After completing the medial orbital block, the needle is drawn back a little and reintroduced

in a more lateral direction toward the central part of the roof of the orbit. The frontal nerve lies there just between the periosteum and the levator palpebræ superioris muscle; the injection must therefore be pushed in close contact with the bone, using 1 c.c. of the 2 per cent. novocain-adrenalin solution. The operative field may be circum-injected, as first practised by Braun, with a view to controlling hemorrhage (Figs. 112 and 113). The possible extension of one of the frontal sinuses beyond the midline, or communication between the two sinuses,

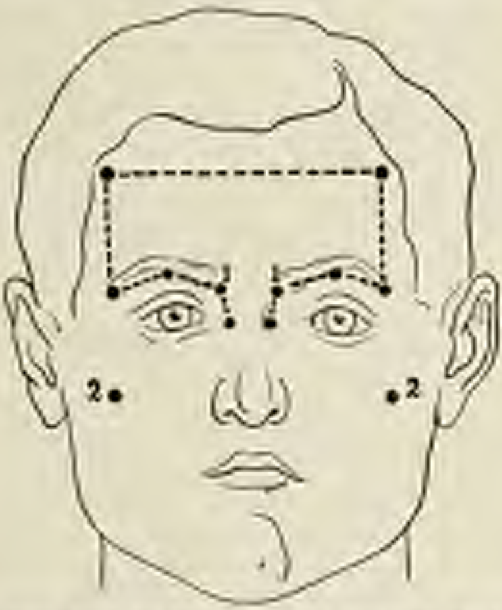

Fig. 113.—Regional block for bilateral radical operation on the frontal sinuses: 1, Medial orbital block; 2, maxillary block. The dotted lines indicate the subcutaneous injections for the field-block.

prompts the induction of a wide anesthetic field for unilateral operations, as shown in Fig. 112, before the operation is begun.

OPERATIONS ON THE LIPS

The **upper lip** is anesthetized from two points, one on each side, at the angle of the mouth, by injections made along two lines in the direction of the alæ of the nose (Fig. 114). The needle is advanced submucously, while its point is guided by a finger in the mouth. The

subcutaneous tissue is then infiltrated, using in all from 5 to 10 c.c. of the 1 per cent. solution. The lip is then tested by light pricks made with a spare needle, and, if the anesthesia is not satisfactory, supplementary injections are made at the base of the lip, uniting the upper extremities of the lateral lines of infiltration.

For **hare-lip operations** the upper lip is injected as above described, along two lines from the angle of the mouth to the alæ of the nose, using only from 2 to 3 c.c. of the 0.5 per cent. solution on each side. The

Fig. 114.—Field-block of the upper lip.

infra-orbital block by the oral route is then performed by distributing the solution on the anterior aspect of the maxilla in the immediate neighborhood of the infra-orbital foramen. A last injection is made beneath the alæ of the nose, while the needle is still in the gingivolabial fold, on one side in case of single hare-lip, on both sides in double hare-lip, using 5 c.c. of the same solution. The adrenalin contained in the solution greatly controls the hemorrhage, and the anemic condition of the tissues changes entirely the aspect of the operation.

The **lower lip** is anesthetized by introducing the needle through a

Fig. 115.—Field block of the lower lip.

Fig. 116.—Blocking of the lower lip and chin: A, Site of puncture on the lower border of the mandible, 3 cm. from the midline; A-1 and A-3 are submucous and subcutaneous injections; A-2 blocks the mental nerve close to the bone.

wheal raised in the middle of the chin and infiltrating the soft tissues obliquely upward toward the angle of the mouth (Fig. 115), advancing

the needle subcutaneously as well as submucously, with a finger in the mouth serving as guide. From 10 to 15 c.c. of the 1 per cent. solution is sufficient to produce anesthesia without distorting the operative area. The mental block by the extra-oral route (page 109) is a procedure which has the advantage of being cleaner than the above described wedge-shaped infiltration and of dismissing all possibilities of contaminating the healthy tissues surrounding the lesion. If the lesion lies at the angle of the mouth, a very wide anesthetic field is obtained by blocking the mandibular nerve at the foramen ovale by the zygomatic route (page 95) and the infra-orbital nerve by the extra-oral route (page 90).

OPERATIONS ON THE EYE

An instillation of 2 or 3 drops of a 2 to 5 per cent. novocain-adrenalin, or cocain, solution in the conjunctival sac is quite sufficient for superficial operations on the cornea and conjunctiva. If the instillation is repeated every two or three minutes for about half an hour the anesthetic solution penetrates the cornea, and the fluid contents of the anterior chamber and the iris, as a rule, become insensitive. The conjunctival sac is particularly suitable for local applications of anesthetic agents which remain in the closed sac formed by the closure of the eyelids. During a considerable time the anesthetic fluid is kept in contact with and spreads over tissues which possess a high power of absorption. The following operations need no other form of anesthesia: superficial interventions on the conjunctiva, treatment of corneal ulcers by cautery, removal of foreign bodies from the conjunctiva and cornea, plastic on the cornea, cataract operations, iridectomy, and other operations on the lens and iris.

Operations in the Orbit.—The anesthesia of the orbit and its contents is easily realized by injecting the nerve supply of these structures at the apex of the orbital cavity. This procedure has already been described as the lateral orbital block (page 69) and medial orbital block (page 70). The lower eyelid is, as a result, completely anesthetized, although part of its sensory nerve supply originates from the infra-orbital nerve; a condition which is probably due to the diffusion of the injected fluid, or to the edema of the eyelids.

Enucleation and exenteration of the eye are painlessly performed after blocking the orbital structures in the following manner: With the left forefinger running along the lower margin of the orbit, the lower lateral angle of the orbital cavity is defined. Needle No. 2 (5 cm.), free from the syringe, is introduced at that angle, through a wheal previously raised, and advanced in a perpendicular direction toward the floor of the orbit where a first bony contact is taken. Inclining the shaft of the needle downward and a little inward, the needle is then directed toward the lateral wall of the orbit and advanced along that wall, keeping in close contact with it, while the bulb of the eye is retracted upward and inward by a finger of the left hand. After passing between the inferior rectus and abducent muscles the point of the needle is stopped by the bony surface immediately below the sphenoidal fissure, at a depth of about 3.5 cm. from its point of entrance. The direction of the needle is backward, upward, and inward, almost aiming at the apex of the orbit. Not more than 2 c.c. of the 2 per cent. solution should then be injected slowly and gradually, watching at the same time the condition of the eyelids and bulb. If the gradual displacement of the bulb forward and edema of the eyelids seem to suggest that there will be an exaggerated protrusion of the eyeball and edema of the eyelids after the medial injection has been performed, the quantity of solution injected should be reduced accordingly.

The needle is then drawn back a little and advanced a little more inward behind the bulb, within the muscular cone of the eye, toward the ciliary ganglion (Fig. 117), where 2 c.c. of the same solution are again injected. These injections are almost painless. It is not necessary to be in contact with the ciliary ganglion when injecting; it is sufficient to be in its immediate neighborhood, since the loose diffluent adipose tissue in which it lies facilitates the diffusion of the fluid.

The medial orbital block completes the anesthesia: the needle is withdrawn from the orbit and reintroduced through a wheal raised at about 1 cm. above the inner canthus, on the margin of the orbit. After taking contact with the bone the needle is advanced in close contact with the medial wall of the orbit, along its upper angle, until a depth

of about 3.5 cm. has been reached, where 2 c.c. of the 2 per cent. novocain-adrenalin solution are injected. Light massage of the eyelids and bulb is soon followed by complete anesthesia of the contents of the

Fig. 117.—Orbital block for enucleation and exenteration of the eye: a, Lateral orbital block; b, ciliary ganglion block; c, medial orbital block.

orbit. Occasionally the massage is superfluous, provided a few minutes are allowed before the operation is begun.

If the anesthetic fluid has been injected judiciously the exophthalmos is slight and the closure of the eyelids due to spreading edema does

not preclude the immediate use of retractors. The anemic condition of the whole region adds to the advantages of the regional method, which make it the procedure of choice in eye operations.

Operations on the Eyelids.—The anesthesia of the eyelids is easily accomplished by injections carried along the margins of the orbit. Needle No. 2 (5 cm.) is introduced at the midpoint of the lower margin of the orbit for the lower eyelid, midpoint of the upper margin of the orbit for the upper eyelid, and advanced toward the inner canthus,

Fig. 118.—Field-block of the eyelids.

then toward the outer canthus (Fig. 118), passing just beneath the skin. The injection is made while the needle is advanced. The edema thus precedes the point of the needle and traces its path in the thin structures of that region. According to the technic advocated by Duverger, only one site of puncture is sufficient for the injection of both eyelids, the needle being introduced at the outer canthus and advanced beneath the skin toward the inner canthus, passing along the upper and lower margins of the orbit. The solution is injected while the needle is advanced, using 2 c.c. of the 2 per cent. solution in either lid.

If the operation does not involve other structures of the eye an instillation of a few drops of a 5 per cent. novocain-adrenalin, or cocain, solution in the conjunctival sac renders the operation on the eyelids with this procedure painless.

OPERATIONS ON THE EAR AND MASTOID REGION

The surgery of the ear comprises operations on the auricle, external auditory canal, drum-head and tympanic cavity, and mastoid process and cells or mastoid region.

Fig. 119.—Sensory nerve supply of the auricle of the ear (external aspect).

The sensory nerve supply of the *auricle* originates from the auriculotemporal nerve (branch of the mandibular nerve), great auricular and small occipital nerves (branches of the cervical plexus), and auricular branch of the vagus. The *external auditory canal* is innervated by the auriculotemporal nerve (anterior part), great auricular nerve (outer part), and auricular branch of the vagus (posterior part). The auriculo-

temporal and auricular branch of the vagus enter the external auditory canal at the union of its cartilaginous and bony parts. The *drum-head* is supplied, on its outer aspect, by the auriculotemporal nerve (upper part) and the auricular branch of the vagus (lower part); on its inner or mucous side, by Jacobson's nerve (branch of the glossopharyngeal nerve). The *tympanic cavity* and the *mastoid cells* receive their sensory nerve supply from Jacobson's nerve; the mastoid region, from the cervical plexus (Figs. 119 and 120).

Fig. 120.—Sensory nerve supply of the auricle of the ear (cranial aspect).

Operations on the Auricle.—The auricle is easily anesthetized by subcutaneous injections. Needle No. 2 (5 cm.) is introduced through 2 wheals raised above and below the ear and passed around and beneath the attachment of the ear, using about 20 c.c. of the 1 per cent. solution (Fig. 121).

Operations on the External Auditory Canal.—The external auditory canal is anesthetized by carrying the injections near the bone, as advised by Eicken and Laval. A wheal is raised in front of the tip of

the mastoid process just behind the attachment of the lobule of the ear. The lobule is drawn forward and outward. Needle No. 2 (5 cm.) is introduced through the wheal and advanced deeply along the anterior surface of the mastoid process, behind the auditory canal, until its point reaches the temporal line. After injecting 2 c.c. of the 2 per cent. solution the needle is partially withdrawn and its direction changed, now passing in front of the auditory canal behind the maxillary joint, and advancing as far as the temporal bone (Fig. 122), using 2 c.c. of the same solution. The solution is thus injected at the junction of the cartilaginous and bony parts of the canal where the nerves enter the

Fig. 121.—Field-block of the auricle of the ear.

ear. Very small quantities of fluid are injected while the needle is advanced, the rest being distributed along its path while it is withdrawn. If the mouth is held open while making the second injection the maxillary condyle is kept out of the way.

The external auditory canal may also be insensitized by deep injections made by puncturing the skin of the canal at the junction of the cartilaginous and bony structures of the ear. The needle is inserted successively in each wall, through the skin overlying the cartilage, and advanced obliquely toward the bony margin until its point is felt beneath the periosteum. A few drops of the 2 per cent. novocain-

adrenalin solution are then injected with a little pressure; the puncture in the posterior wall should be made for preference at the union of that wall with the upper wall.

If the needle is advanced a little deeper in the upper wall the injection will reach the mucosa of the tympanic cavity and the ossicles, thus realizing sufficient anesthesia for the removal of these bones. But the drum-head (tympanic membrane) will not be insensitized.

Fig. 122.—Blocking of the external auditory canal.

Operations on the Drum-head.—To insensitize the drum-head for paracentesis or incision of furuncles applications should be made of Bonain's solution, consisting of:

Phenol Menthol Cocain hydrochlorid } .... āā	1 gm.
Adrenalin hydrochlorid	0.006 gm.

A small pledget of cotton moistened with 2 drops of this solution is introduced into the auditory canal and kept for five minutes in contact with the drum-head. The application is renewed for another five minutes, making a total period of ten minutes, which should not be

exceeded, so as to avoid sloughing. Nor should alcohol be used before or after paracentesis, since it increases the causticity of Bonain's solution (Canuyt-Rozier). Absolute anesthesia of the drum-head is rather difficult to realize, owing to its epidermis and its vascularization during an inflammatory process. It is recommended that a few drops of

Fig. 125.—Neumann's injection for the anesthesia of the tympanic membrane and cavity.

adrenalin solution, 1 : 1000, be poured into the ear if the condition following applications of Bonain's solution is not one of complete anesthesia. The operation will then be painless.

Removal of the Ossicles.—If the drum is ruptured when the removal of the ossicles is contemplated, as is ordinarily the case, a few drops of a 10 per cent. cocain-adrenalin solution poured into the ear reaches the

tympanic cavity. But the irregularities of that cavity do not permit of an even distribution of the solution along its walls. The anesthesia, therefore, is not always satisfactory. The external auditory canal must then be injected from inside, as described (page 148), or Neumann's injection (Fig. 125) resorted to and made in the following manner: The junction of the cartilaginous portion of the ear with the bony part of the upper wall of the auditory canal is determined by

Fig. 124.—Field block for mastoidectomy. The dots represent the wheals through which the needle is introduced and advanced subcutaneously in the direction of the arrows.

moving the ear up and down. A fold is thus formed which marks the site of puncture. Needle No. 2 (5 cm.) is introduced in that fold and passed obliquely upward through the cartilage and beneath the periosteum until the bony canal is felt. A few drops of the 2 per cent. solution are there injected and the needle advanced along the upper wall of the canal from 0.5 to 1 cm. further, where 1 c.c. of the same solution is injected with light pressure. The anesthesia sets in about ten minutes after.

Operations on the Mastoid Cells and Tympanic Cavity.—**Operations on the mastoid process and mastoid cells** are painlessly performed by circuminjecting the mastoid region (Fig. 124) with from 15 to 20 c.c. of 1 per cent. novocain-adrenalin solution.

The **radical mastoid operation** is performed by the method first suggested by Neumann and used by Kullenkampff, Braun, and others.

(*a*) With the patient's head lying on the healthy side, an instillation is made into the external auditory canal of a few drops of a 10 per

Fig. 125.—Field-block for the radical mastoid operation, giving a wider anesthetic area: 1, 2, and 3 are the sites of puncture for subcutaneous infiltration; 5, Braun's point of injection of the external auditory canal.

cent. cocain solution containing 1 drop of adrenalin solution. The drum is usually destroyed; the solution, therefore, enters the tympanic cavity and acts upon the mucous membrane during the subsequent injections.

(*b*) The mastoid region and external ear are then blocked by circumferential infiltration of about 40 to 50 c.c. of the 1 per cent. solution (Fig. 125), deep injections close to the bone being made backward

of the mastoid process so as to reach the occipital and great auricular nerves.

(c) The auditory canal is then anesthetized by passing the needle through a point either just behind the ear, as suggested by Braun, or in front of the tip of the mastoid process, as described on page 147. If Braun's puncture is selected, the ear is retracted frontward, the needle is introduced just behind the ear, and passed along the anterior surface of the mastoid process as far as the bony canal, where 2 c.c. of the 2 per cent. solution are injected. Considerable pressure is required so as to distribute the solution evenly around the canal.

(d) Neumann's injection of the upper wall of the canal (page 151) completes the anesthesia. It is occasionally necessary to make a similar injection on the anterior wall of the auditory canal to secure absolute anesthesia.

The contraindications to the method are cases belonging to the acute septic type and perforation of phlegmonous suppurations.

The unpleasant sensation experienced by the patient from the use of the chisel is the principal drawback of the method; but if an injection of morphin ($\frac{1}{6}$ gr.) and scopolamin ($\frac{1}{150}$ gr.) is given an hour before the anesthesia is begun, and, in very nervous patients, a like dose repeated immediately after inducing the anesthesia, the operation will be performed with entire satisfaction both to the patient and the surgeon. The above dose of narcotics should be reduced in children and administered according to age.

OPERATIONS ON THE UPPER JAW

Although the upper jaw is supplied by the maxillary nerve alone, the gasserian ganglion should be blocked for all extensive operations in that region. Such a procedure gives a complete anesthesia of the soft and bony structures of the whole face, including the organs contained in its cavities. The surgical procedures can thus be extended to the adjoining structures without the aid of general narcosis or the use of supplementary injections, always difficult in the course of such operations.

The **drainage of the antrum of Highmore** from the canine fossa, in acute cases, is performed by blocking the infra-orbital nerve, the pos-

terior and middle superior dental nerves, and distributing the solution on the anterior surface of the maxilla, all over the operative area. This last injection controls the hemorrhage. The infra-orbital and superior dental nerves may be blocked from without or through the mouth, as already described (pages 80 and 89). These nerves can be injected from a single site of puncture situated beneath the lower angle of the malar bone. The needle, introduced through a wheal raised at that

Fig. 126.—Regional block for the radical operation for empyema of the antrum of Highmore: 1, Medial orbital block; 2, maxillary block; 3, point of injection along the lower margin of the nasal bone, beneath the ala of the nose, frenum, and midline of the upper lip.

point, is inserted transversely through the cheek, passing below the infra-orbital foramen, and advanced as far as the bone of the nose, where 5 c.c. of the 2 per cent. solution are injected. The needle is then drawn back until its point reaches the subcutaneous tissue and directed backward on the posterior aspect of the maxilla, injecting again 5 c.c. of the 2 per cent. or 10 c.c. of the 1 per cent. solution (Braun).

The **radical operation for chronic empyema of the antrum of Highmore,** consisting in the excision of the anterior and nasal wall, requires

a wider zone of anesthesia, which is secured by the maxillary block (page 72) and the medial orbital block (page 70). Circuminjection of the operative field, as illustrated in Fig. 126, serves to check the hemorrhage.

The **partial or total resection of the upper jaw** is performed by blocking the maxillary nerve (page 72) and making the medial and lateral orbital blocks (pages 69 and 70). The lateral orbital block is not necessary if the floor of the orbit is not interfered with. Circuminjection of the operative field with from 30 to 40 c.c. of the 1 per cent. solution is here also recommended to control bleeding (Fig. 127). In case of unilateral resection, unilateral block is sufficient, provided the incision does not extend beyond the midline. The gasserian ganglion block is always to be preferred for such operations, since it gives, before the operation is begun, a wider anesthetic area to work on, especially in case of emergency. The palate and pharynx should be painted with a 10 per cent. cocain solution to prevent reflex vomiting.

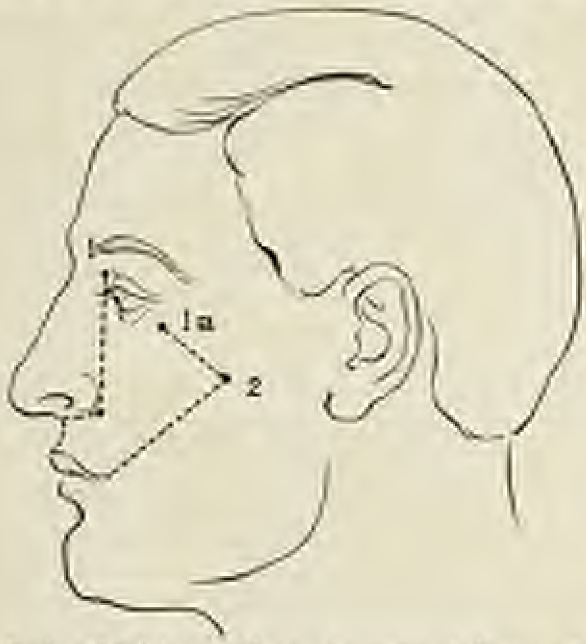

Fig. 127.—Regional block for partial or total resection of the upper jaw: 1, Medial orbital block; 1a, lateral orbital block; 2, maxillary block. The dotted lines indicate subcutaneous injections for the field block.

OPERATIONS ON THE LOWER JAW

The sensory nerve supply of the lower jaw and floor of the mouth is derived from the mandibular nerve. By blocking this nerve at the foramen ovale (page 92), or the inferior dental and lingual nerves at the lingula (page 99), it is easy to perform any operation on the lower jaw. But it should be remembered that, if the operation is made from without, the overlapping cervical nerves must, in addition, be controlled by subcutaneous injections along the lower border of the jaw, or the cervical plexus blocked on the posterior margin of the sternocleidomastoid muscle (page 168). The subcutaneous injection of the 1 per cent. solution around the operative area gives a completely dry field, and is recommended, even though the whole area has been anesthetized by a nerve-block.

OPERATIONS ON THE PAROTID GLAND

Tumors of the parotid gland are excised by blocking the mandibular nerve at the foramen ovale on the side of the lesion and circuminjecting the tumor with from 40 to 50 c.c. of the 1 per cent. solution. The injection is also carried beneath the lower part of the tumor, which is ordinarily more or less movable on the structures of the neck. Injections should not be made into the tumor. The cervical nerves are thus blocked, even if the tumor is very large and extends over the neck, overlapping the usual points of approach of the cervical plexus by the lateral route (page 174); but these nerves may, however, be reached by the posterior route (page 172). For the mandibular block there is ordinarily only one route available, that of Hartel, for blocking the gasserian ganglion (page 94), but the distortion of the region renders the technic somewhat difficult, inasmuch as the zygomatic arch and tubercle of the zygoma are hidden by the tumor. With patience and experience of the gasserian ganglion block it is, however, possible to obtain satisfactory results. It is not necessary to inject the nerve itself, but to make the injection in its close vicinity. Facial paralysis due to the injection of the anesthetic fluid, especially in front of the tumor, is transient, disappearing with the return of sensibility.

OPERATIONS ON THE TONGUE

The tongue is supplied by the lingual and glossopharyngeal nerves, as illustrated in Figs. 128 and 129, its anterior two-thirds receiving its sensory innervation from the lingual nerve, while its posterior third is the territory of the glossopharyngeal nerve. The epiglottis receives filaments from the superior laryngeal nerve. The floor of the mouth is supplied by the lingual nerve.

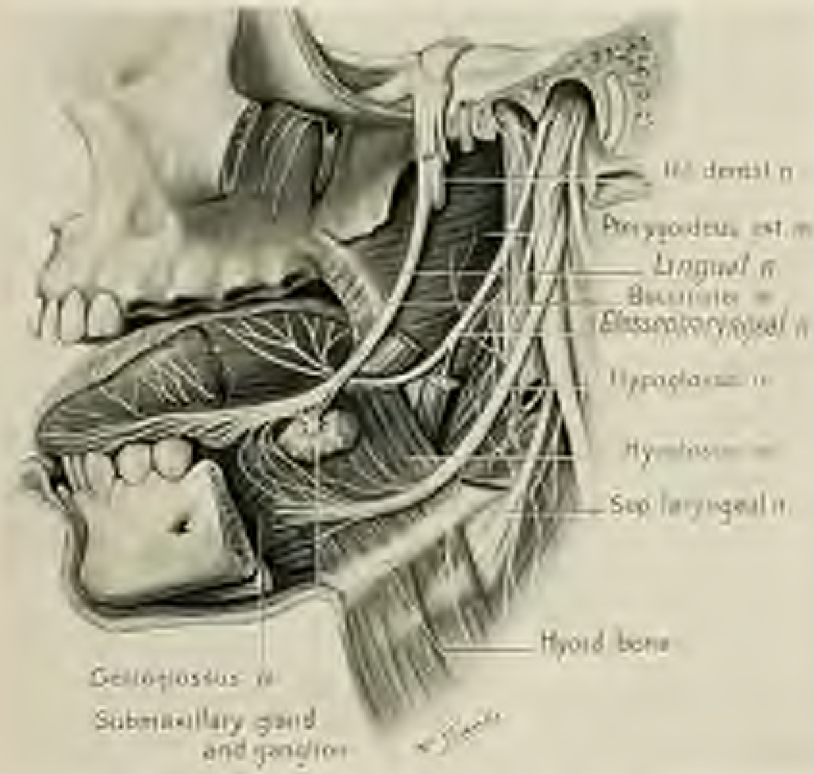

Fig. 128.—Sensory nerve supply of the tongue.

The lingual nerve is ordinarily blocked at the lingula; the glosso-pharyngeal and superior laryngeal nerves are reached by infiltrating the base of the tongue (Fig. 130). The author has no experience with Hirschel's method of blocking the glossopharyngeal and vagus nerves at the base of the skull; but the occasional after-effects following the blocking of both superior and inferior laryngeal nerves for total laryn-

Fig. 129.—Areas of the sensory nerves of the tongue.

Fig. 130.—Blocking of the tongue from a point of entrance just above the midpoint of the hyoid bone.

gectomy are not so encouraging as to justify any attempt on his part to block the vagus.

In case of **partial resection** of the tongue, if the growth is situated at or near the tip of the tongue, a wall of anesthesia involving its entire thickness is raised across the organ at a little distance from the lesion; if the lesion lies on the side of the tongue the injections are made in two planes at right angles to each other, one of them being parallel to the long axis of the tongue, thus anesthetizing the quadrant bearing the growth.

If the extent of the lesion necessitates a wider anesthetic field, the entire tongue and floor of the mouth are anesthetized from without through a point of entrance just above the midpoint of the hyoid bone. Needle No. 3 (8 cm.) is introduced through a wheal previously raised just above the midpoint of the hyoid bone and advanced toward the tip of the left index-finger placed on the base of the tongue near the epiglottis (Fig. 130). Painting the base of the tongue with a 10 per cent. cocain solution facilitates the contact of the finger. Infiltration is made while the needle advances as well as when it is withdrawn. The needle is then drawn back so as to change its direction and reintroduced a little more laterally in a transverse plane to meet the base of the tongue. These injections are repeated through the same site of puncture while the needle is directed more and more obliquely toward the angle of the jaw on both sides, using from 40 to 50 c.c. of the 0.5 per cent. solution. A wall of anesthesia is thus raised from one ramus of the jaw to the other, cutting off the nerve supply of the tongue and floor of the mouth, with consequent anemia of the operative field due to the adrenalin contained in the solution.

Total resection of the tongue is performed by means of regional anesthesia induced in the following manner:

(*a*) Painting the palate, pharynx, and base of the tongue with a 10 per cent. cocain solution to prevent reflex vomiting.

(*b*) Blocking the dental and lingual nerves at the lingula (page 99).

(*c*) Blocking the cervical plexus by the lateral route (page 174).

(*d*) Blocking the superior laryngeal nerve (page 112).

(*e*) Infiltrating the base of the tongue (page 159).

If the surgical procedures involve the pillars, tonsils, and lateral wall of the pharynx, it is preferable to block the maxillary nerve in the

sphenomaxillary fossa (page 74), the mandibular nerve at the foramen ovale (page 95), and the cervical plexus by the lateral route (page 174). The maxillary and mandibular blocks are performed from a single point of entrance below the midpoint of the zygomatic arch (Figs. 43, 44, 67, and 68).

Transverse incision of the cheek, preliminary to certain operations in the mouth or necessitated by the extension of the growth to the

Fig. 131.—Injection for transverse incision of the cheek. The dotted line represents the line of infiltration along the intended line of incision.

pharynx, is made by infiltrating the cheek along a line drawn from the angle of the mouth to the angle of the jaw. Needle No. 3 (8 cm.) is inserted through a wheal raised on that line just in front of the masseter muscle and advanced subcutaneously and submucously toward the angle of the mouth, with the left index-finger placed in the mouth to guide the needle and prevent it from piercing the mucosa (Fig. 131). This is one of the rare instances in which infiltration of the anesthetic

solution along the line of incision is allowed for the sake of simplifying the technic; but this injection is superfluous when the maxillary and mandibular nerves have been blocked. It is, however, recommended to control bleeding.

For operations on the floor of the mouth the lingual nerve is blocked at the lingula. This injection blocks at the same time the dental nerve, and results in the anesthesia of the tongue as well as of the lower jaw. The simultaneous insensitization of these structures facilitates the approach of the lesion lying in the floor of the mouth. Circuminjecting the lesion is necessary to control bleeding. This is done by inserting needle No. 2 (5 cm.), previously connected with the syringe, through a wheal raised under the chin and infiltrating the entire thickness of the structures of the floor of the mouth. The injections are made fanwise with 0.5 per cent. solution, a finger being placed in the mouth to guide the point of the needle.

TONSILLECTOMY

The tonsillar region is supplied by the middle and posterior palatine nerves and the glossopharyngeal nerve. It receives occasionally filaments from the anterior palatine nerve. The palatine nerves approach the tonsil by its upper pole and are distributed chiefly to the upper portion of the mucous covering of the gland. The glossopharyngeal nerve gives off tonsillar branches near the base of the tongue. They are slender filaments which form around the tonsil a plexus called *circulus tonsillaris*. The lingual nerve occasionally contributes to form this plexus (Testut), from which filaments are given off to the tonsil, the soft palate, and the faucial pillars. The sensory nerves of the tonsils, therefore, approach the gland by its poles and are easily reached by the anesthetic fluid injected at these points in the following manner: After painting the tonsillar region with a 10 per cent. cocain solution, taking the usual precautions to prevent swallowing, the anterior pillar is given a coat of 3.5 per cent. tincture of iodin. Needle No. 3 (8 cm.), already connected with the syringe, is inserted through the anterior pillar, at the level of the upper pole of the tonsil, and advanced in the loose connective tissue lateral to the tonsil, where from 3 to 5 c.c. of the 1 per

cent. solution are injected while the needle is advanced. The needle is then withdrawn and reintroduced through the anterior pillar, but this time at the level of the lower pole of the tonsil, and another injection made in the manner just described. The solution diffuses in all directions in the areolar tissue in which lies the tonsil laterally, and

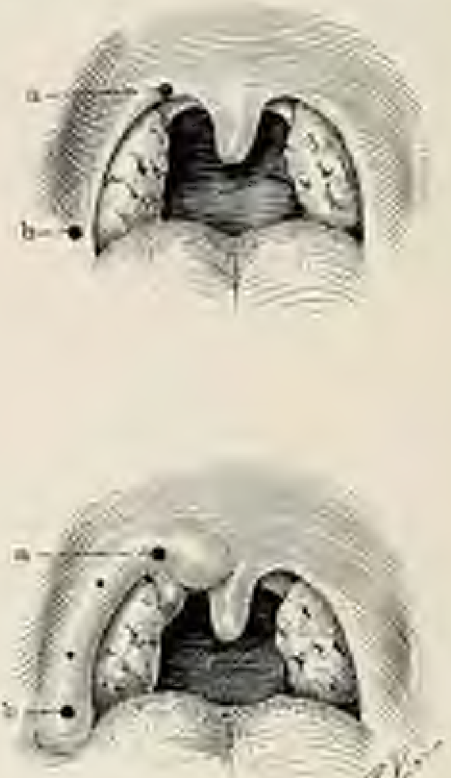

Fig. 132.—Field-block for tonsillectomy: *a* and *b* are the points of entrance of the needle at the poles of the tonsil. The anterior pillar is infiltrated from the two intermediate small dots.

owing to the resistance offered to the injected fluid by the pharyngeal wall, the tonsil bulges out, thus facilitating its enucleation. Sometimes the needle must be advanced in an outward direction (Fig. 133), occasionally the anterior pillar of the fauces punctured more laterally, so as to avoid injecting the solution uselessly within the gland or between the gland and the pillar. The anterior pillar is then injected from

two intermediate points with from 2 to 3 c.c. of the same solution to control bleeding (Fig. 132). It is necessary to wait five minutes to obtain absolute anesthesia.

Pharyngeal tonsils are anesthetized by local applications of concentrated anesthetic solutions. Two applicators are moistened with a 10 per cent. novocain-adrenalin solution and introduced deeply into the nasal cavities, one on each side between the middle and inferior turbinates, until they are stopped by the nasopharyngeal wall. The applicators are kept in place for about three minutes, during which

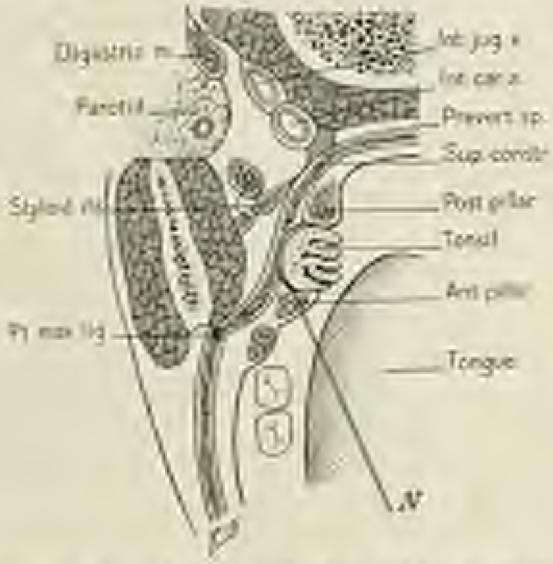

Fig. 133.—Cross-section through the faucial pillars and tonsils, showing the direction of the needle, *N*.

the faucial tonsils are injected in the manner already described. The applicators are renewed if necessary. Painting the palate and nasopharynx with a 10 per cent. cocain solution minimizes the discomfort of the patient; but the drug should be used cautiously, as previously stated.

DENTAL OPERATIONS

Teeth extractions, with or without preliminary external alveolectomy, and all other dental operations are best performed by nerve-block. A thorough knowledge of the sensory nerve supply of both jaws is indis-

pensable before attempting the injections. Figures 134–138 illustrate the areas of nerve supply of the masticatory apparatus better than any description.

Upper Teeth.—*Molars.*—Two injections are sufficient to anesthetize the three molars at the same time: the superior posterior dental block by the oral route (page 80) and the posterior palatine block (page 84).

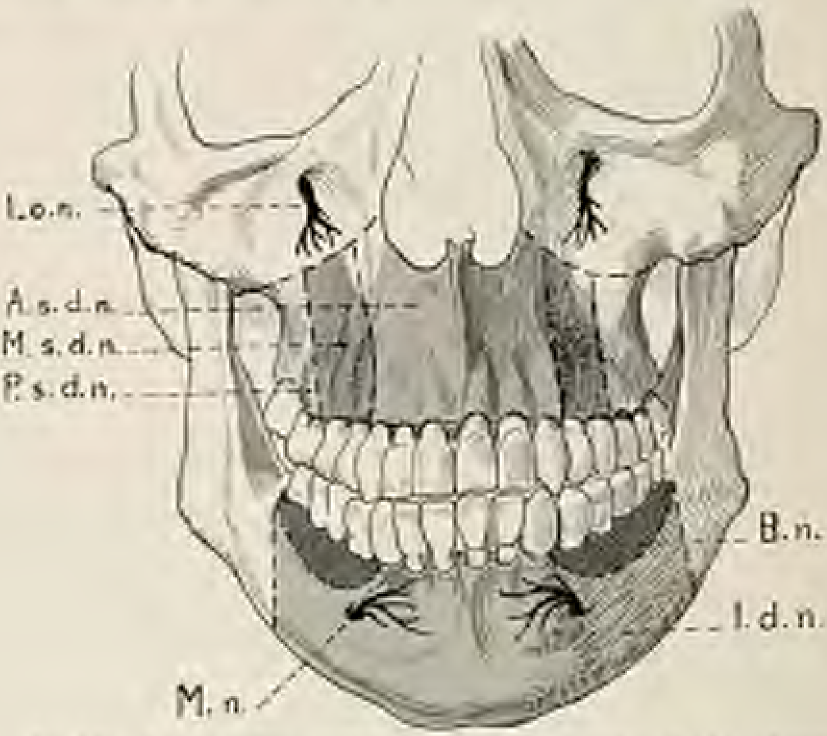

Fig. 134.—Areas of nerve supply of masticatory apparatus: *A.s.d.n.*, Anterior superior dental nerve; *M.s.d.n.*, middle superior dental nerve; *P.s.d.n.*, posterior superior dental nerve; *I.d.n.*, inferior dental nerve; *B.n.*, buccinator nerve; *I.o.n.*, infra-orbital nerve; *M.n.*, mental nerve.

Bicuspids and Cuspid.—The upper bicuspids and cuspid are anesthetized by the superior posterior dental block by the oral route (page 80), the infra-orbital block (page 89), and the anterior palatine block (page 84). This procedure anesthetizes also the incisors.

Incisors.—The incisor teeth are insensitized at the same time as the canine (cuspid) by the infra-orbital block (page 89) and the anterior

Fig. 135.—Areas of the nerve supply of the maxilla: *A.s.d.n.*, Anterior superior dental nerve (incisor and canine regions); *M.s.d.n.*, middle superior dental nerve (bicuspid region); *P.s.d.n.*, posterior superior dental nerve (molar region).

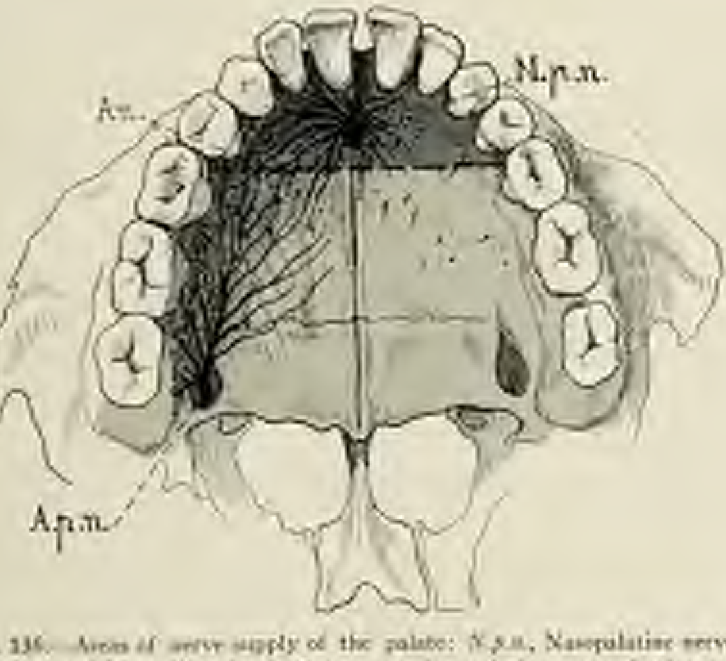

Fig. 136.—Areas of nerve supply of the palate: *N.p.n.*, Nasopalatine nerve (incisor, canine, and bicuspid regions); *A.p.n.*, anterior palatine nerve (molar region); *An.*, anastomosis.

palatine block (page 84) associated with the injection of 1 c.c. of the 2 per cent. solution beneath the frenum of the upper lip. The anesthesia of the incisors alone is realized by submucous injections made in the labial fold at the apex of the teeth, and by the anterior palatine block (page 84).

Lower Teeth.—All the lower teeth are anesthetized at the same time by the inferior dental block at the lingula (page 99). In case of surgical extraction (partial external alveolectomy preliminary to extraction) it is necessary to block also the area supplied by the buccinator (Fig. 137) by injecting 2 c.c. of the 2 per cent. solution below and anterior to the opening of Stenson's duct (opposite the first or

Fig. 137.—Areas of nerve supply of the anterior section of the mandible: *Light gray*, Inferior dental nerve; *dark gray*, buccinator nerve, contributing to the sensory innervation of the mucous membrane in the molar and bicuspid regions; *M.n.*, mental nerve.

second upper molar tooth), or by infiltrating the mucous reflection opposite the operative field. This procedure is recommended for the extraction of any of the molars or bicuspids.

Bicuspids, Cuspid, and Incisors.—The cuspid and incisor teeth are completely anesthetized by the mental block (page 108), the oral route being chosen, as is usual in dentistry. The bicuspids do not always become insensitive by this procedure, since the injection cannot be made within the mental foramen. If the anesthetic fluid is injected with a little pressure just at the foramen, and the region submitted to light massage, diffusion ordinarily takes place through the foramen to the filaments supplying the bicuspids. If these teeth are not com-

pletely anesthetized a few minutes after the mental block has been performed, injection must be made of the inferior dental nerve at the lingula (page 99). Here also the areas supplied by the buccinator and lingual nerves must be insensitized by submucous injections made at the level of the teeth involved in the operation.

Incisors.—The incisors only are anesthetized by submucous infiltration on each side of the midline, both on the labial and on the lingual aspect of the teeth.

The lip is retracted downward and the needle introduced in the mucous reflection at about the level of the apex of the canine and

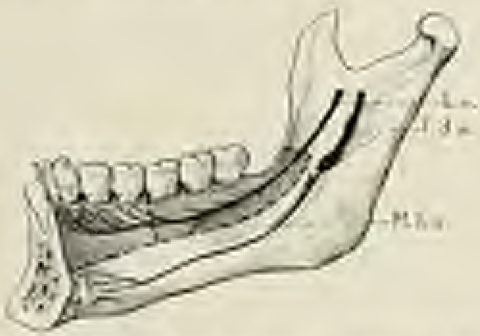

Fig. 138.—Areas of nerve supply of the lingual section of the mandible: *I.d.n.*, inferior dental nerve (molar region); *L.n.*, lingual nerve; *M.h.n.*, mylohyoid nerve. *Dark area* in the molar region is the territory of the inferior dental nerve; *light gray area* in front of it indicates contribution brought in by the lingual nerve.

advanced forward, downward, and slightly inward until the mental fossa is reached, below the apices of the canine and lateral incisor. About 1 c.c. of the 2 per cent. solution is then injected as the needle is moved a little to and fro, so as to distribute the solution evenly in the fossa and allow its diffusion into the mandible through the foramina ordinarily present in this region of the bone. Lingual injections of small quantities of solution are then made behind the central incisors and parallel to their long axis and also between the cuspid and first bicuspid. This procedure anesthetizes the canine also.

CHAPTER V

BLOCKING OF SPINAL NERVES

Paravertebral Block

(Paravertebral Conduction Anesthesia)

Paravertebral block, called by Läwen "paravertebral conduction anesthesia," is accomplished when an anesthetic solution is distributed close to the vertebral column, at the emergence of the nerve trunks from the intervertebral foramina.

Paravertebral block is ordinarily performed at all heights of the spine, and each procedure is called by the name of the vertebral segment to which it belongs. "Paravertebral cervical block" means blocking of the cervical nerves; "paravertebral dorsal block," that of the dorsal nerves; "paravertebral lumbar block," that of the lumbar nerves, and "paravertebral sacral block," that of the sacral nerves. Paravertebral sacral block is termed "transsacral block" when the injections are made through the posterior sacral foramina, and "presacral block" when the anesthetic fluid is distributed on the anterior aspect of the sacrum.

Paravertebral Cervical Block

(Blocking of the Cervical Plexus)

The sensory nerve supply of the neck is chiefly due to the first four cervical nerves. The anterior primary divisions of these nerves communicate freely and form the cervical plexus. After emerging from the intervertebral foramina they pass behind the vertebral artery and reach the tip of the transverse processes, the first between the rectus capitis lateralis and the rectus capitis anticus muscles, the other three between the intertransversales muscles. The first does not divide; the second, third, and fourth each divide into an ascending and a descending branch, which are connected in a series of loops lying close to the

transverse processes of the first four cervical vertebræ, mostly under cover of the sternocleidomastoid muscle, constituting the cervical plexus. They all communicate with the sympathetic chain by means of rami communicantes.

Fig. 139.—The cervical plexus.

From these loops two sets of branches are given off, viz., the superficial cervical and the deep cervical branches (Fig. 139).

The *superficial cervical branches* reach the deep fascia of the neck at about the middle of the posterior margin of the sternocleidomastoid

muscle, become superficial, and radiate to their respective cutaneous territories. The ascending branches (small occipital and great auricular nerves) supply the occipitomastoid region of the head, the auricle of the ear, and the parotid gland, the transverse branch (superficial cervical

Fig. 140.—Superficial branches of the cervical plexus at their emergence on the posterior margin of the sternocleidomastoid muscle.

or *cutaneus colli*) is distributed chiefly to the anterior part of the neck between the lower border of the jaw and the sternum; the descending branches (suprasternal, supraclavicular, and supra-acromial) innervate the shoulder and upper pectoral region (Fig. 140).

The posterior primary divisions of the cervical nerves supply the

posterior structures of the neck and head and give off cutaneous branches, most of which run obliquely downward and outward and

Fig. 141.—Cutaneous territory of the superficial branches of the cervical plexus, overlapping the upper thoracic region as a cape.

overlap the upper region of the back, supplied by the dorsal nerves. The blocking of the cervical plexus close to the spine is, therefore, followed by a zone of anesthesia which involves not only the teguments

of the neck, posterior aspect of the head and ear, but spreads over the upper part of the thorax and shoulders as a cape, and interferes, as will be seen later on, with the anesthesia of the upper part of the thorax and the upper extremity (Fig. 141).

The *deep cervical branches* supply chiefly the deep structures of the lateral and anterior regions of the neck; they give off the phrenic nerve and contribute to form the hypoglossal loop or *ansa cervicalis*.

The cervical plexus is blocked by injecting the anesthetic fluid in the immediate vicinity of the transverse processes of the cervical vertebræ, thus realizing the anesthesia of its deep as well as its superficial branches. The superficial branches can, however, be blocked separately by subcutaneous and subfascial injections made along the posterior margin of the sternocleidomastoid muscle.

The cervical plexus may be approached by either the posterior route (Kappis) or the lateral route (Heidenhain).

Posterior Route.—With the patient lying on either side, the head sharply bent on the sternum and supported by cushions to prevent distortion of the structures of the back of the neck and render the landmarks more accessible, the spinous processes of the cervical vertebræ are defined, starting from the seventh, ordinarily the prominent.

If the spinous processes cannot be defined by palpation, a horizontal tracing (vertical in the lateral position of the patient) is made around the neck, passing by the lower border of the cricoid cartilage. This tracing marks the level of the transverse process of the sixth cervical vertebra. The transverse processes of the fifth, fourth, third, and second cervical vertebræ are 1.5, 3, 4.5, and 6 cm. respectively above the sixth transverse process.

Wheals are raised opposite the spinous processes of C^2, C^3, and C^4,[1] or at the aforementioned levels, at points 2 cm. distant from the midline (Fig. 142).

[1] C^2, C^3, and C^4 mean the second, third, and fourth vertebræ. These symbols will hereafter be used to denote vertebræ, or spinal nerves. The capital letter (initial of the segment of the spine) represents the segment to which the vertebra, or nerve, belongs, and the index to which the letter is raised, the number of such vertebra or nerve. Example: D^{12} means twelfth dorsal vertebra, or twelfth dorsal nerve, according to the meaning conveyed by the sentence.

Needle No. 3 (8 cm.) is passed through each of these wheals in succession and introduced in a direction parallel with the sagittal plane of the neck, until its point reaches the lateral masses of the vertebræ. The depth to which the needle is introduced varies with the thickness of the tissues overlying the vertebral column. The needle is drawn back until

Fig. 142.—Cervical plexus block by the posterior route. Superficial landmarks referred to the skeleton. The wheals raised opposite the spinous processes, at 2 cm. from the midline, are good for the cervical region only.

its point reaches the subcutaneous tissue and reintroduced a little obliquely outward. As soon as its point is felt gliding along the lateral aspect of the vertebral arch the needle is advanced 1 cm. further and 5 c.c. of the 1 per cent. solution injected while the needle is moved a little to and fro.

With a little experience it is easy to understand that the posterior

route of approach is not very accurate, owing to the difficulty of taking the superficial landmarks, and because of the thickness of the tissues overlying the transverse processes (Fig. 143). The posterior route is only used in cases of pathologic conditions of the lateral structures of the neck.

Lateral Route.—The superficial landmarks are here numerous and reliable, in contrast to what is found on the back of the neck. The

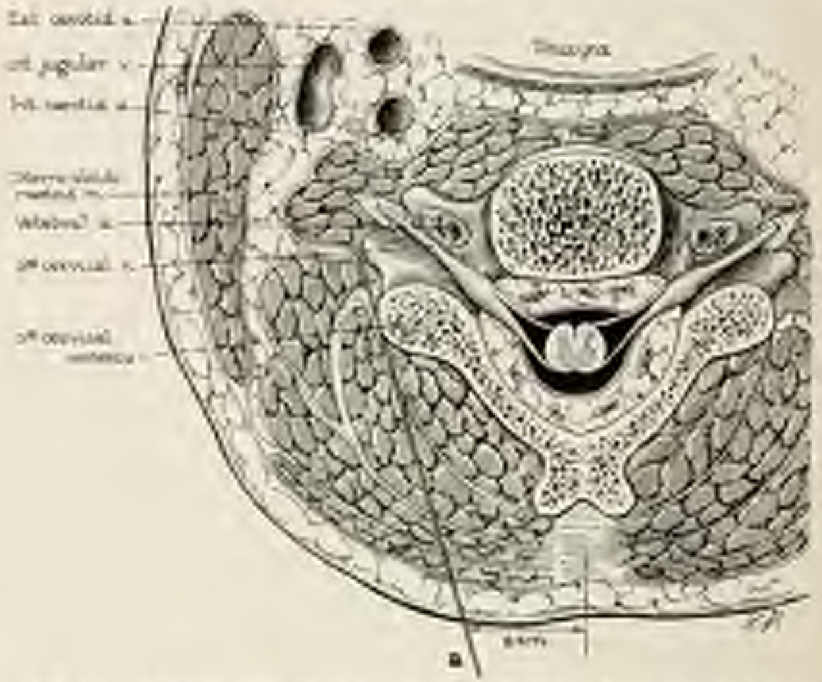

Fig. 143.—Cervical plexus block by the posterior route. Cross-section of the neck at the level of the third cervical vertebra, showing the direction of the needle (a) inserted at a point 2 cm. from the midline of the back of the neck. Note the thickness of the tissues traversed in order to reach the vicinity of the cervical nerve.

transverse processes, although deeply situated in some patients, can always be felt by palpation, and their general direction traced on the skin with great accuracy. In certain patients the tip of the mastoid process and anterior tubercle of the sixth transverse process (tubercle of Chassaignac) are the chief landmarks, the line joining these points representing the general direction of the transverse processes of the cer-

vical vertebræ. In stout patients the sternocleidomastoid muscle, the external jugular vein, and the thyroid cartilage are reliable landmarks.

There are two procedures used for blocking the cervical plexus by the lateral route:

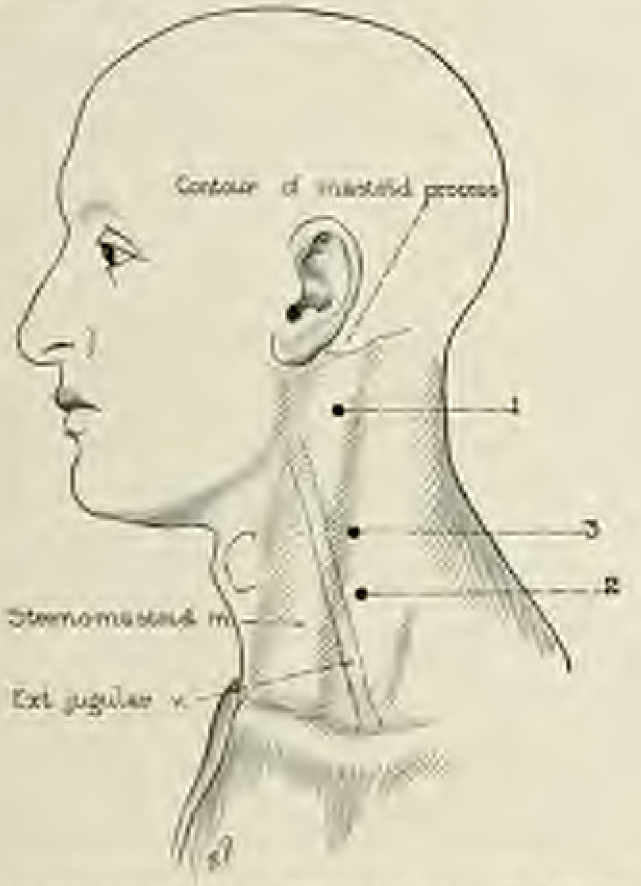

Fig. 141.—Cervical plexus block by the lateral route: 1 is one fingerbreadth below the tip of the mastoid process; 2 marks the tubercle of Chassaignac (sixth transverse process); 3 is opposite the superior cornu of the thyroid cartilage. Injections are made through 1 and 3 only.

1. With the patient lying on his back, head tilted on the opposite side, the tip of the mastoid process and the tubercle of Chassaignac, easily palpable in the majority of cases, are joined by a straight line made with a sterile dermographic pencil or an applicator moistened with tincture of iodin. The upper margin of the thyroid cartilage is

produced backward to cut this line. On the line joining the tip of the mastoid process to the tubercle of Chassaignac three wheals are raised: the first, one fingerbreadth below the tip of the mastoid process, is ordinarily at the level of the angle of the jaw; the second, over the tubercle of Chassaignac; the third, opposite the superior cornu of the thyroid cartilage, at the intersection of the two lines already traced on the skin.

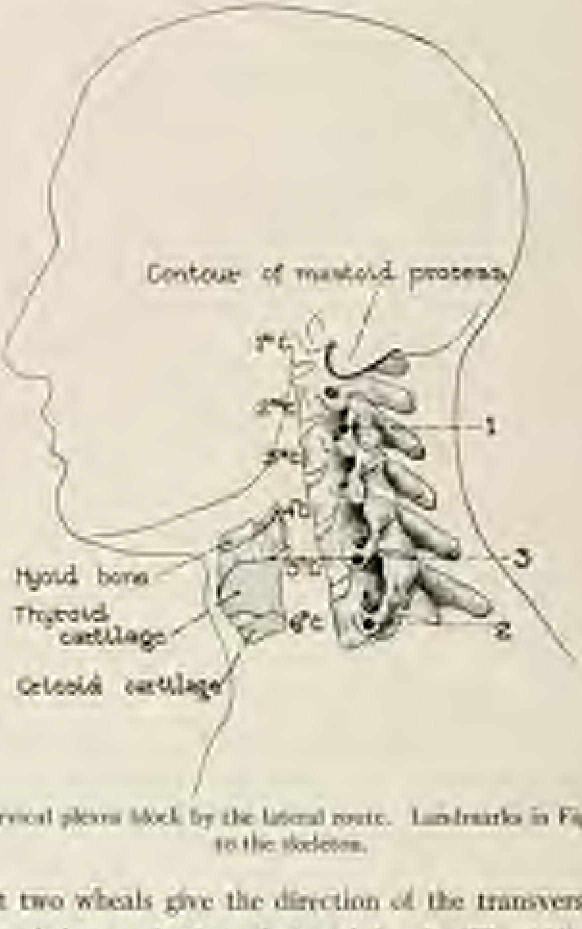

Fig. 145.—Cervical plexus block by the lateral route. Landmarks in Fig. 144 referred to the skeleton.

The first two wheals give the direction of the transverse processes, the injections being made through 1 and 3 only (Fig. 144), which correspond to C^3 and C^5, as illustrated in Fig. 145.

The needle is introduced through these wheals in succession and advanced transversely toward the spine, until its point reaches the tip of the transverse processes of C^2, C^3, and C^4, where the injection is

made, according to the following technic: With the tip of the last four fingers of the left hand the soft structures overlying the row of transverse processes are moved about, sometimes with a little pressure, so as to feel this part of the framework and locate, if possible, the transverse processes individually. Very easy in lean patients, it is a rather difficult task in short, fat necks, where the bony parts are lost beneath the thickness of the soft structures. Needle No. 2 (5 cm.), with its hub held firmly between the thumb and index-finger of the right hand, is

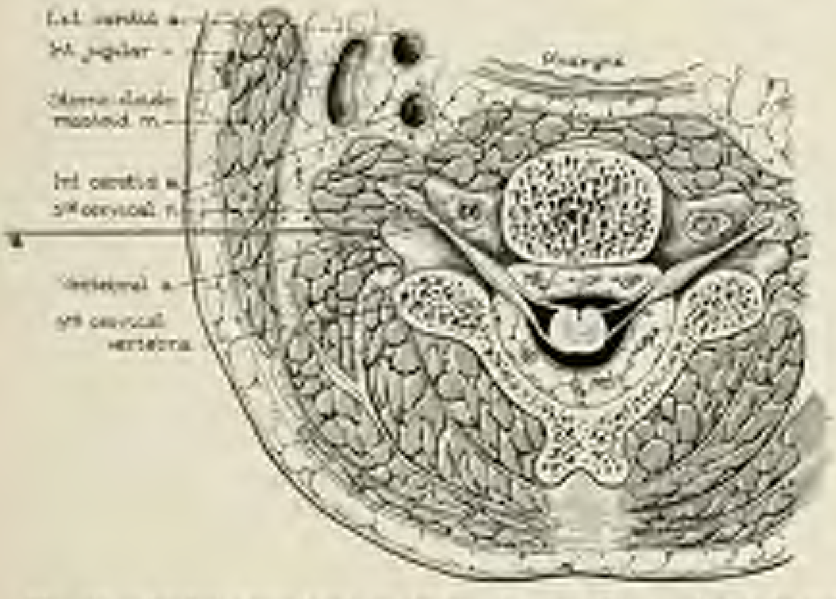

Fig. 145.—Cervical plexus block by the lateral route. Cross-section of the neck at the level of the third cervical vertebra, showing the direction of the needle (a). Note the comparatively thin layer traversed by the needle and the distance of the large blood-vessels from the path of the needle and site of injection.

inserted through the lower wheal 3 and advanced toward the tip of the fourth transverse process, while the index-finger of the left hand guides its approach. When the point of the needle has taken contact with the bone, it is gently held against it, while the syringe, previously half-filled with the 1 per cent. solution, is being connected with the needle. Injection is then made of 3 or 4 c.c. of the solution without moving, and the rest of the contents of the syringe discharged while the needle is partially drawn back. The syringe is disconnected and the needle

reintroduced toward the transverse process next in height, always guided by the index-finger of the left hand, and the injection made in the manner just described. The needle is then withdrawn from the lower wheal and inserted through the upper wheal. The second transverse process is not easy of access to the palpating finger; so that the needle must be advanced cautiously in the depth, taking as guide the direction and depth it had reached during the first injections.

Care must be exercised not to allow the needle to pass either between or in front of the transverse processes for fear of puncturing the blood-vessels (carotid artery, internal jugular vein, and vertebral vessels). A hematoma following the puncture of one of these vessels with the fine needle cannot cause death; but it should be avoided because, among other reasons, it occasionally adds to the distortion created by the pathologic condition of the region or stands in the way of the surgeon, being at times misleading. The transverse processes of the cervical vertebræ are, besides, thin and sharp edged, offering but a poor surface of approach, while the space between any two of them is rather wide and opens the way to the intervertebral foramen. Such a disposition establishes favorable conditions for intraspinal puncture, with consequent injury to the cord, especially when the needle is advanced in an upward direction. The needle should not, therefore, be introduced too deeply; but the bony contact attempted while the point of the needle is still in the superficial layers of the structures of the neck, by puncturing fanwise in the plane passing through the row of transverse processes, gradually advancing the needle deeper in that plane.

After blocking the cervical plexus close to the spine it is customary to distribute the solution subcutaneously and subfascially along the posterior margin of the sternocleidomastoid muscle, using about 15 c.c. of the 1 per cent. solution. These injections are made from the lower site of puncture.

The quantities of fluid injected vary with the weight of the patient, but seldom exceed 30 c.c. for the deep injections and 20 c.c. for the superficial infiltration, on each side, making a total of 100 c.c. of the 1 per cent. solution. The strength of the solution may be reduced to 0.75 per cent. in the majority of cases, without noticeable interference

with the duration of anesthesia for goiter operations, using the same quantities as of the 1 per cent. solution. The 1 per cent. solution gives a better anesthetic field for block dissection of the glands of the neck.

2. In short necks one site of puncture is ordinarily sufficient for the blocking of the cervical plexus. A wheal is raised on the posterior margin of the sternocleidomastoid muscle, 1.5 cm. behind the external

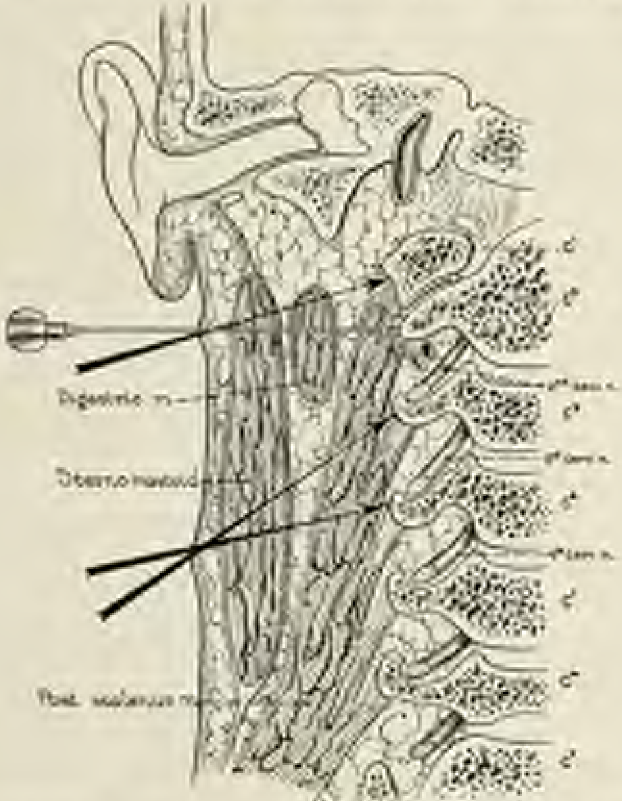

Fig. 147.—Cervical plexus block by the lateral route. Frontal section of the right half of the neck, passing through the sites of puncture (1 and 3 of Fig. 144).

jugular vein, and through this wheal the needle is inserted and advanced a little obliquely downward toward the row of transverse processes which the left hand feels in the depth. When the depth of the vertebral column has thus been ascertained, the solution is distributed in close proximity to the transverse processes of C^2, C^3, and C^4, using the method already described for approaching them. Subcutaneous and

subfascial injections are then made along the posterior margin of the sternocleidomastoid muscle, using 100 c.c. of a 0.75 per cent. novocain solution containing 15 drops of adrenalin solution 1 : 1000.

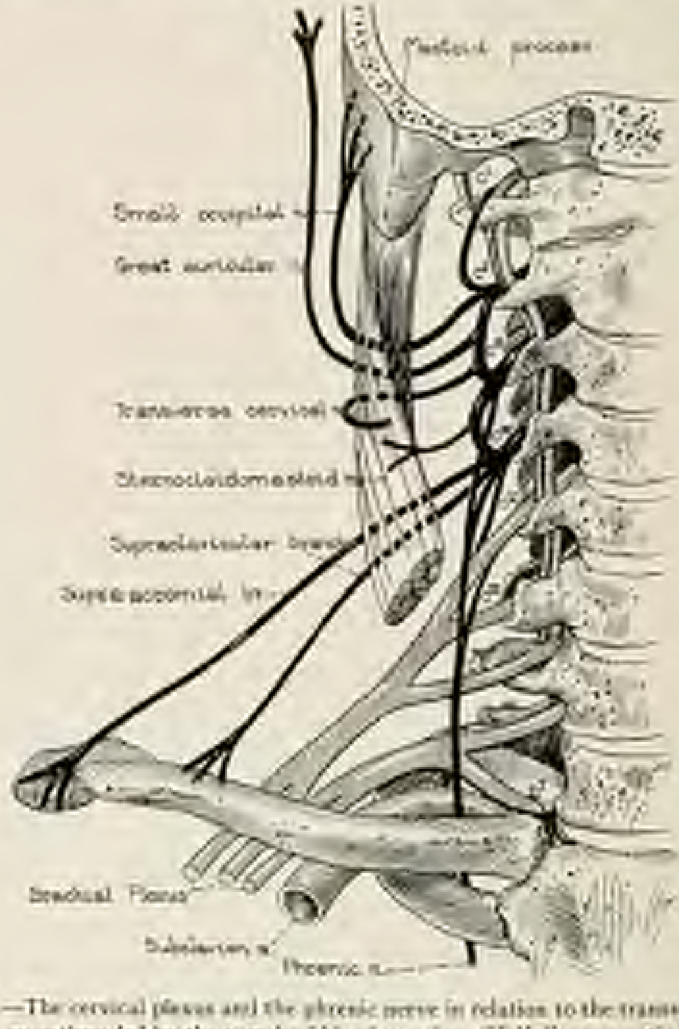

Fig. 148.—The cervical plexus and the phrenic nerve in relation to the transverse processes threaded by the vertebral blood-vessels. (Half-diagrammatic.)

When the cervical plexus block is induced for thyroidectomy about half the usual dose of adrenalin solution (8–10 drops per 100 c.c.) is used, except in exophthalmic goiters, where no adrenalin is added to the anesthetic fluid, but more time allowed for the anesthesia to set in.

Bilateral blocking of the cervical plexus is not attended or followed by functional disturbances in the territory of the phrenic and the vagus nerves. Wiemann found that for thyroidectomies, when regional anesthesia is induced the day before the operation with a view to determining the exact mechanism of the occasional after-effects resulting from paravertebral injections, *x*-rays in a certain number of cases reveal paresis of the diaphragm on the same side, but without any subjective disturbances. The pulse is sometimes slowed, sometimes accelerated, and sometimes unaffected. The most interesting feature of this experiment is the absence of any trouble at the operation the next day, although the anesthesia is applied on both sides with three or four times as much of the solution.

The author has a great many times made bilateral blocking of the cervical plexus and has no recollection of having noticed symptoms attributable to the total or partial inhibition of the vagus and phrenic nerves. If the injections are made close to the transverse processes laterally there is little risk, if any, of blocking the vagus; but it seems reasonable to believe that the phrenic nerve is blocked in every case, since it originates chiefly from C^4 (Figs. 139 and 148), although not to such an extent as to paralyze the diaphragm, and that the intercostal and other respiratory muscles compensate for the functional deficiency of the diaphragm.

Brachial Plexus Block

(Blocking of the Brachial Plexus)

The brachial plexus is formed by the intricate interlacement of the anterior primary divisions of the lower four cervical and the first dorsal or thoracic nerves; it receives contributions from the second and third thoracic nerves, occasionally from the fourth also. After leaving the intervertebral foramina these nerves converge toward the upper surface of the first rib, where they emerge in the interval between the scalenus anticus and scalenus medius muscles. From the side of the neck they pass beneath the clavicle and enter the axilla through its apex. The brachial plexus is, therefore, divided into two portions: a cervical or supraclavicular, and an axillary or infraclavicular portion. The supra-

clavicular portion of the plexus has the shape of a triangle, having its base attached to the cervical vertebral column and its apex at the clavicle. It lies first above and then on the outer side of the subclavian artery and vein, and is frequently threaded by the transverse cervical or posterior scapular artery. In the axilla the component parts of the plexus form a close fasces around the axillary artery, although lying

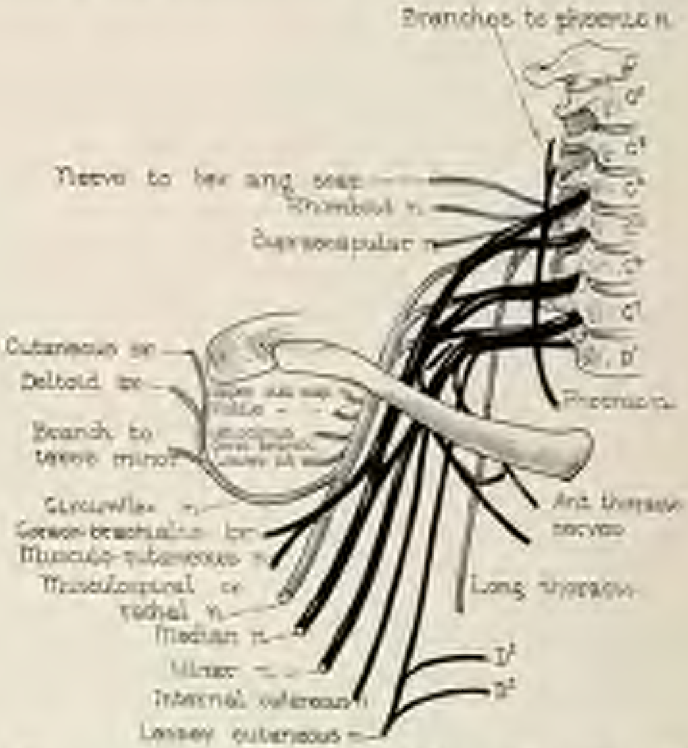

Fig. 149.—Diagrammatic illustration of the brachial plexus, showing the supraclavicular and infraclavicular branches of the plexus. The posterior divisions are colored pale.

on the outer side of it. Before dividing into its terminal branches it lies enclosed between the pectoralis minor and subscapularis muscles. The fifth and sixth cervical nerves unite to form the outer or upper trunk; the eighth cervical and first thoracic unite to form the inner or lower trunk; the seventh cervical remains alone as the middle trunk. On emerging from the scaleni muscles, each of these trunks separate into an anterior and a posterior division. The six divisions, three

anterior and three posterior, unite differently to form three cords, from which branches are given off which can be divided into two groups, viz.: supraclavicular and infraclavicular.

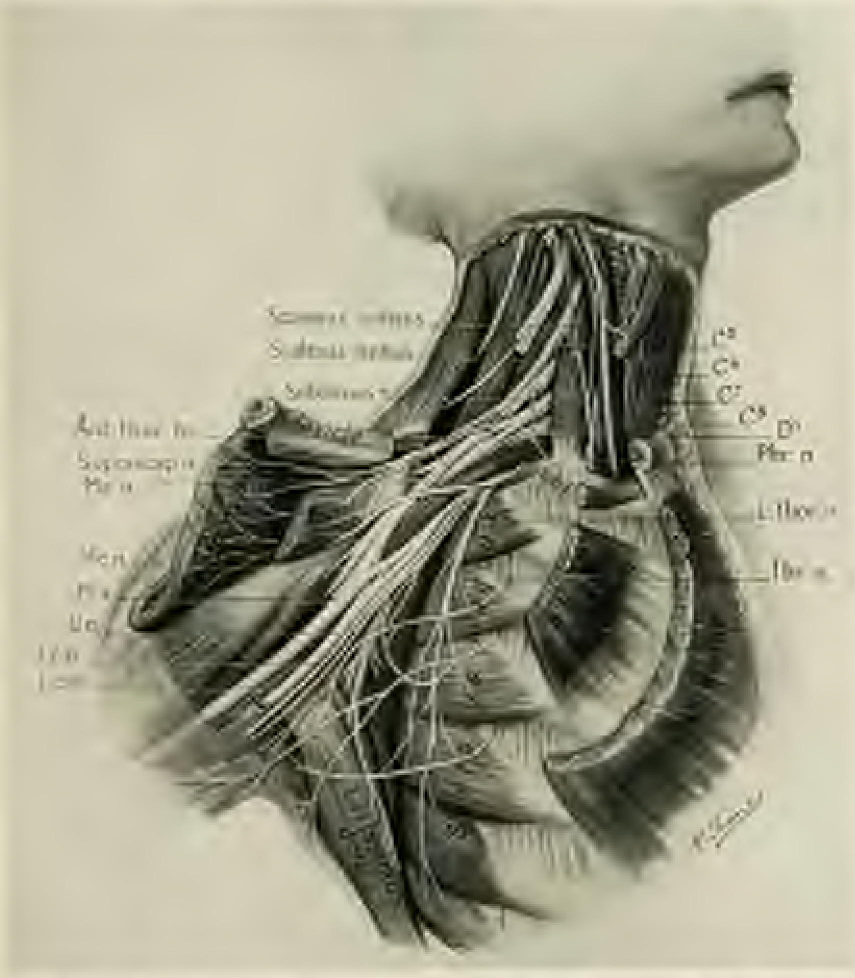

Fig. 150.—The brachial plexus (after Hirschfeld and Leveillé): *Ms.n.*, Musculospiral nerve; *Mc.n.*, musculocutaneous nerve; *M.n.*, median nerve; *U.n.*, ulnar nerve; *I.c.n.*, internal cutaneous nerve; *L.c.n.*, lesser cutaneous nerve; *Phr.n.*, phrenic nerve; *L.thor.n.*, long thoracic nerve; *Ib.n.*, intercostobrachialis (intercostohumeral) nerve.

The *supraclavicular branches* are given off at various levels, sometimes from the trunks, while the plexus is still in the neck. They supply the longus colli, supraspinatus, infraspinatus, levator anguli scapulæ,

rhomboidei major and minor, serratus magnus, scaleni anticus, medius and posticus and subclavius muscles, and the shoulder-joint.

The *infraclavicular branches* supply the pectorales major and minor, coracobrachialis, teres major and minor, latissimus dorsi and subscapularis muscles, and give off muscular, articular, and cutaneous branches which are distributed to the upper extremity.

In studying the topography of the base of the neck, with special reference to the brachial plexus and the relation it bears to the surrounding structures, one finds that:

(*a*) The *first rib* lies in a horizontal plane slightly inclined frontward and downward, with the pleural dome in its concavity. The rib crosses the clavicle, or passes beneath it, generally at about the union of its inner and middle thirds, and forms with the *clavicle* an acute angle, very seldom a right angle, opened outward and backward.

(*b*) On emerging from the scaleni muscles the *brachial plexus* crosses the upper surface of the first rib, then passes beneath the clavicle, which it crosses at about its midpoint and almost at right angles to it, on its way to the axilla.

(*c*) The *subclavian artery* also passes between the same scaleni muscles, and crosses the first rib and the clavicle, running side by side with the brachial plexus. The artery passes in front of the plexus and crosses the clavicle a little more obliquely than the plexus. The *transverse cervical artery* (external branch of the subclavian artery) runs outward across the posterior aspect of the scalenus medius muscle, passes between the cords of the plexus, thence around the scalenus posticus muscle, and continues its way in the deeper structures beneath the trapezius muscle. The *superficial cervical artery* runs parallel with, but is more superficial than, the transverse cervical artery. It passes in front of the scalenus anticus muscle and crosses the posterior triangle of the neck at about 2.5 cm. above the clavicle. Occasionally the superficial cervical artery, or one of its anastomoses with the transverse cervical artery, is so enlarged that it can easily be mistaken for the subclavian artery when palpating the region.

The foregoing considerations of the descriptive and topographic anatomy of the region bring out the following important points:

1. The brachial plexus is accessible just above the clavicle, owing to its situation in the superficial layers of the region.

2. The component parts of the plexus unite in a bundle which crosses the clavicle at about its midpoint and to the outer side of the subclavian artery, an ideal condition for blocking the whole plexus from a single site of puncture, above the midpoint of the clavicle.

3. The plexus and the artery lie side by side in the angle formed by the first rib and the clavicle.

4. The artery, being superficial, lends itself to palpation, and can thus be located.

5. The first rib is a very important landmark, since it serves as a screen to prevent the needle from entering the pleural dome.

6. The brachial plexus can also be reached from a point of puncture below the clavicle a little lateral to its midpoint.

Four routes have been devised for blocking the brachial plexus: (1) paravertebral (Kappis); (2) axillary (Hirschel); (3) infraclavicular (Louis Bazy); (4) supraclavicular (Kulenkampff).

Paravertebral Route.—With the patient lying in the recumbent lateral position, a cushion under the head so as to obtain as complete relaxation as possible, wheals are raised opposite the spinous processes of C^5, C^6, C^7, and D^1, on a line 3 cm. distant from and parallel to the midline of the nape.

Through these wheals needle No. 3 (8 cm.) is introduced in a plane parallel with the sagittal plane of the neck, and advanced toward the vertebral arch, on which it impinges at a certain depth which varies with the thickness of the structures of the back of the neck. It is then withdrawn a little and slightly inclined outward so as to pass tangentially to the lateral aspect of the vertebral arch; when the point of the needle loses contact with the bone, it is introduced 1 cm. deeper, and 5 c.c. of 1 per cent. solution are injected. Through the last or lowest wheal the needle should impinge on the first rib, pass beneath it, and be inclined a little inward toward the spine, so as to reach the first thoracic nerve.

Axillary Route.—With the patient lying on his back, the upper extremity placed in 90 degrees abduction, the axillary artery is defined

by palpation and retracted downward by the index-finger. Needle No. 4 (10 cm.) is introduced through a wheal raised under the lower border of the pectoralis major muscle, close to its brachial attachment, and advanced in a direction parallel with the axis of the arm, along the outer wall of the axilla, deeply beneath the muscle (Fig. 151). After making sure that the point of the needle is not lying in the lumen of a blood-vessel, the syringe is gently connected with the needle and injec-

Fig. 151.—Brachial plexus block by the axillary route. The axillary artery is retracted downward by the index-finger of the right hand, while the needle is inserted by the left hand on the lower border of the pectoralis major muscle, close to its brachial attachment, in a direction parallel with the axis of the arm.

tion made of from 10 to 15 c.c. of the 2 per cent. solution. The syringe is almost completely discharged in the depth, and the rest of the solution distributed while the needle is withdrawn. The axillary artery is then retracted upward (toward the pectoralis major) by the index-finger, and the needle inserted through another wheal raised a little below the first site of puncture (Fig. 152). The needle is advanced deeply behind the artery, in a direction parallel with the axis of the

arm, along the outer wall of the axilla, thus aiming at its apex, so as to reach the radial (musculospiral) nerve in front of the head of the latissimus dorsi muscle. If no paresthesias are obtained, part of the solution is injected in the depth, and the rest while the needle is withdrawn, as for the first injection, using from 10 to 15 c.c. of the 2 per cent. solution. But if the needle happens to hit one of the main branches of the plexus during its progression in the axillary space it should be

Fig. 152.—Brachial plexus block by the axillary route. The axillary artery is retracted upward and the needle, inserted through a wheal raised a little below the first site of puncture, is advanced behind the artery.

stopped and the injection made without moving. The axilla is then lightly massaged for a while to hasten the diffusion of the anesthetic fluid.

As a rule the needle is never attached to the syringe when it is introduced in the vicinity of large blood-vessels. Time is allowed before connecting the syringe, and the aspiration test made and renewed, so as to make sure that the point of the needle does not lie in the lumen of a blood-vessel.

It has been advised to start the injection as soon as the needle has reached a depth of from 2 to 3 cm., distributing the solution while the needle is advanced, with a view to clearing the way in front of its point, thus avoiding the puncture of a blood-vessel. This practice is objectionable. As a matter of fact, if the point of the needle encounters a large blood-vessel at a short distance from its point of entrance, after the injection has been started, it cannot be assumed that the blood-vessel will always be pushed aside by the injected fluid. The lack of resistance of the neighboring loose adipose tissue is more likely to produce contrary results under the pressure of that fluid. The number and size of the axillary blood-vessels and their situation around the nerves, added to the direction in which the needle is advanced, which is almost parallel to these blood-vessels, are favorable conditions for intravenous injections. If a blood-vessel, therefore, is punctured while the fluid is being injected, the presumption is that a considerable amount of fluid, not to say the whole contents of the syringe, will be discharged into the blood-stream without the anesthetist's knowledge, the importance of the injection varying directly with the distance traveled by the point of the needle within the lumen of the blood-vessel.

Differences exist in the resistance offered to the point of the needle by the structures contained in the axillary space. Adipose tissue opposes little or no resistance, but these differences can only be registered by the fingers if the needle is advanced gently and gradually, free from the syringe. Any resistance in the depth must not be overcome by force, but the direction of the needle should be slightly changed, thus avoiding the possible puncture of a blood-vessel. The needle, therefore, should be inserted free from the syringe and advanced gently and gradually with enough pressure to overcome the resistance of the fatty structures of the axilla and its direction slightly changed if the resistance increases. With these precautions, it seldom happens that a blood-vessel is punctured; should this happen, as shown by the blood flowing out of the needle, the needle is drawn back a few millimeters and its direction slightly changed. Paresthesias are occasionally obtained in the territory of one of the main branches of the plexus; but it frequently happens that the whole shaft of the 10 cm. needle gradually

disappears in the tissues without giving rise to radiating sensations. It is useless, not to say risky, to try to hit the nerves by repeated punctures made in different directions. The anatomic features of the region are such that one should consider it as a good fortune to have placed the needle in its correct position without puncturing a blood-vessel.

Infraclavicular Route.—The patient is placed in the recumbent dorsal position with a suitable hard cushion under the spine, between the shoulders, so that his arm may hang backward over the edge of the table, in extension and 45 degrees abduction. The coracoid process thus becomes more prominent and the brachial plexus more superficial. The abduction of the arm should be such that its medial aspect, if prolonged upward to meet the anterior tubercle of the transverse process of C^6 (tubercle of Chassaignac), passes one fingerbreadth medial to the coracoid process. This condition exists when the arm is in about 45 degrees abduction.

The operator stands on the side to be operated upon, between the arm of the patient and the table. The tip of the coracoid process is defined by palpation and the depression just medial to it traced on the skin. The tubercle of Chassaignac is likewise defined and traced on the skin by a dot made with an applicator moistened with tincture of iodin. The straight line joining the two dots marks the direction of the brachial plexus (Fig. 153). Needle No. 3 (8 cm.) is inserted through a wheal raised on 1-2 just above the lower dot and advanced upward in the direction of the upper dot. After taking contact with the clavicle, the needle is withdrawn a little and passed behind the bone tangentially to its posterior aspect. As soon as the point of the needle has reached the level of the upper surface of the clavicle, injection is made of 10 c.c. of the 2 per cent. solution, without altering the position of the needle; the arm is then flexed and drawn toward the chest, thus relaxing the brachial plexus, which, in becoming more superficial, naturally advances toward the point of the needle. Another injection is finally made of 10 c.c. of the same solution without displacing the needle.

Supraclavicular Route.—With the patient lying on his back, the

arm alongside of the body, the shoulder on the side to be injected is brought downward so as to lower the clavicle. The operator stands on the side to be injected, facing directly the supraclavicular region, at about the level of the midpoint of the clavicle. In this position the anesthetist should be able to visualize those structures at the base of the neck that are the chief landmarks for the brachial plexus block.

Fig. 153.—Brachial plexus block by the infraclavicular route: 1, Depression medial to coracoid process; 2, tubercle of Chassaignac; +, site of puncture; 1–2 marks the direction of the brachial plexus and that of the needle.

indispensable for a good technic, viz.: the brachial plexus and subclavian artery, both lying side by side in the angle formed by the first rib and the clavicle (costoclavicular angle), and crossing the clavicle at its midpoint (Fig. 154).

The midpoint of the clavicle is determined by taking half the distance between the sternoclavicular and acromioclavicular articulations.

It generally corresponds with the prolongation of the external jugular vein (Fig. 155), which is apparent in the great majority of patients, or can be made salient by asking the patient to blow out his cheeks.

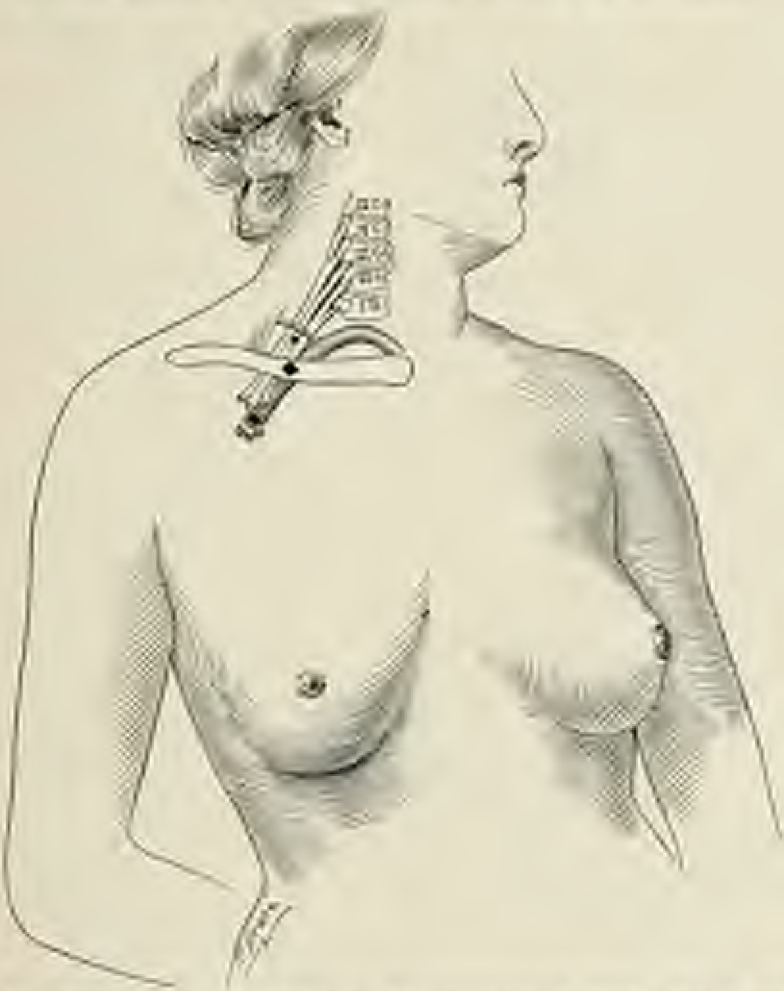

Fig. 154.—Brachial plexus block by the supraclavicular route. The plexus and artery cross the clavicle at its midpoint, represented here by a cross. The dot is the site of puncture, 1 cm. above the midpoint of the clavicle. Note the superficial cervical artery passing in front of the plexus.

The subclavian artery is defined by palpation, and a wheal raised just lateral to it and 1 cm. above the clavicle. In the majority of cases this wheal falls above the midpoint of the clavicle: so that, if the

artery cannot be defined by palpation, it is sufficient to raise the wheal 1 cm. above the midpoint of the clavicle. The patient is now asked to signal on the spur of the moment, but without moving, any "shooting pain" felt in the hand, especially in the little finger. With the index-

Fig. 155.—Brachial plexus block by the supraclavicular route. The midpoint of the clavicle is generally in the prolongation of the external jugular vein.

finger the subclavian artery is retracted inward and downward and needle No. 2 (5 cm.), unattached to the syringe, inserted through the wheal close to the tip of the index-finger, and advanced backward, downward, and inward toward the first rib (Fig. 156).

The needle should be introduced gently and gradually after piercing the deep fascia, since the brachial plexus lies at that level just beneath the fascia. If paresthesias are not obtained after the needle has been

Fig. 156.—Brachial plexus block by the supraclavicular route. With the index-finger on the subclavian artery, the needle is inserted through the wheal raised 1 cm. above the midpoint of the clavicle and advanced in the direction of the first rib.

introduced from 2 to 3 cm., it ordinarily comes in contact with the upper surface of the first rib, unless the needle is advanced in a wrong direction. Absence of paresthesias is a proof that the needle has passed

between the branches of the plexus without touching any of them. The needle should then be partially withdrawn and its direction slightly changed. Contact with one of the cords of the plexus induces radiating

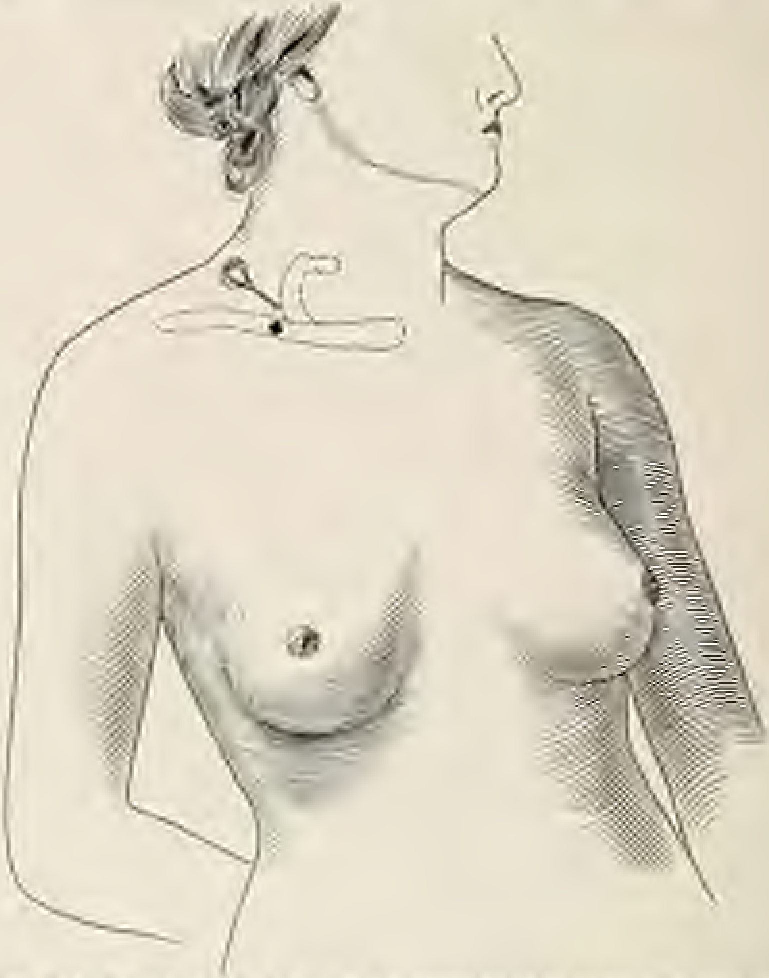

Fig. 157.—Brachial plexus block by the supraclavicular route. The anesthetist, forgetting the plexus and the artery, visualizes only the first rib, which he tries to reach at a point inward, downward, and backward of the site of puncture.

sensations in the hand, more frequently in the little finger. As soon as paresthesias are obtained, injection is made of 10 c.c. of the 2 per cent. solution; but if after two or three attempts no paresthesias are obtained, it is not advisable to try to induce them by repeated punctures made

in different directions. Injection is made of 10 c.c. of the 2 per cent. solution beneath the deep fascia in the direction of the first rib, followed by two supplementary injections made in the following manner: After partially withdrawing the needle so as to change its direction, the nee-

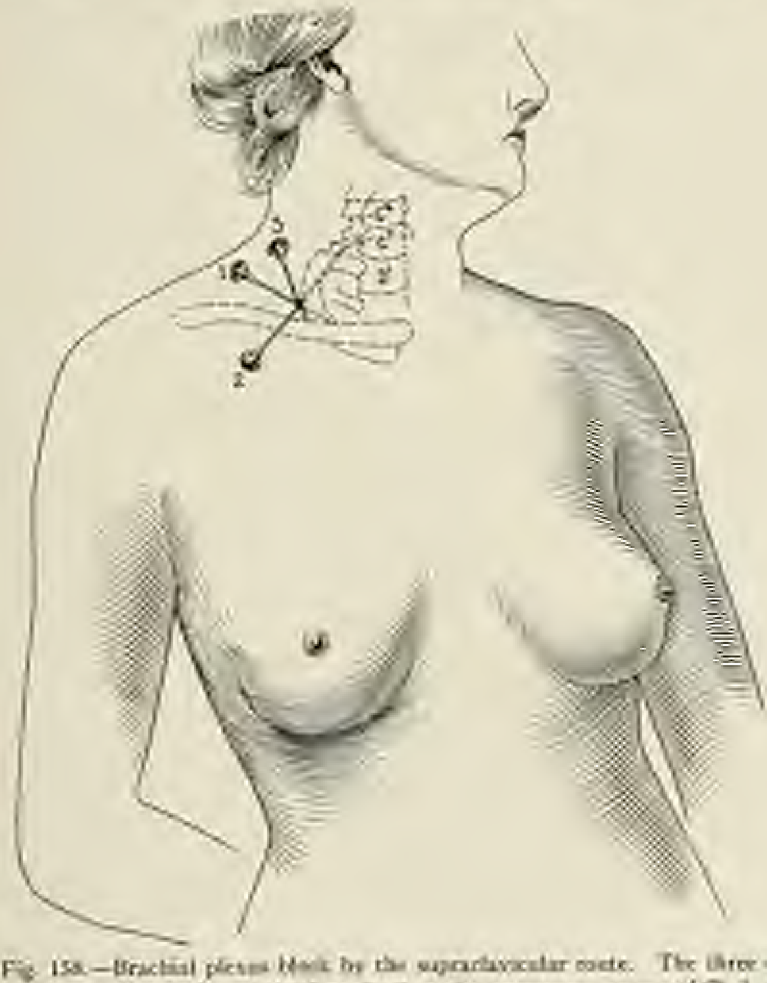

Fig. 158.—Brachial plexus block by the supraclavicular route. The three directions of the needle: 1 aims at the first rib; 2, at the transverse process of C^6; 3, at the lateral margin of the first rib, behind the clavicle.

dle is reintroduced and advanced toward the tubercle of Chassaignac, where injection is made of 5 c.c. of the 2 per cent. solution, after which the needle is again drawn back and advanced toward the lateral margin of the first rib, behind the clavicle, where another injection is made of

5 c.c. of the same solution (Fig. 158). The region is lightly massaged to hasten the diffusion of the injected fluid, and ten minutes are allowed before the operation is begun.

Below the transverse process of C^6 (tubercle of Chassaignac) emerges the seventh cervical nerve which forms the axis of the brachial plexus. When the solution is distributed at that point, it diffuses up

Fig. 159.—Brachial plexus block by the supraclavicular route. Diagrammatic illustration of the three injections; the darker area is that of Kulenkampff.

and down close to the spine in the loose connective tissue in which are embedded the trunks of the plexus, and reaches at the same time those of the supraclavicular branches that are given off very high. The third injection made on the lateral margin of the first rib completes the anesthesia, in case one of the nerve trunks joins the plexus beyond the first rib, after passing in front of the scalenus anticus muscle and the subclavian artery, and is retracted at the same time as the artery.

It seldom happens that paresthesias are not induced while making these three injections. Anesthesia is almost instantaneous following paresthesia; in other cases ten minutes should be allowed before the operation is begun. Hyperemia of the upper extremity is the rule. Paresis is more frequent than paralysis, since the patient is able, in the majority of cases, to move his forearm and fingers during the operation. It can, therefore, be said that motor function is reduced, but not always abolished.

The anesthesia obtained after blocking the brachial plexus is not distributed evenly from the shoulder to the tip of the fingers, but leaves a zone of hypesthesia over the shoulder and on the inner aspect of the arm, occasionally as far as midway between the axilla and the elbow (Fig. 160). This latter part is under the control of the two intercostohumeral nerves joining the lesser internal cutaneous nerve. In order to obtain complete anesthesia, including the shoulder, it is necessary to infiltrate the axilla fanwise along its thoracic wall, and make subcutaneous injections along the clavicle and acromion, so as to check the sensory nerve supply coming from the superficial branches of the cervical plexus.

The technic just described is somewhat different from that of Kulenkampff, who was the first to block the brachial plexus above the clavicle. The site of puncture is the same, but the anesthetic fluid is injected at three different levels, thus distributing the solution along the path of the plexus and in close proximity to the cervical column. Paresthesias are not searched for. The needle aims at the first rib and not in the direction of the spinous process of the first or second dorsal vertebra, which is not very easy to do when the patient is in the recumbent dorsal position.

Indications.—The *paravertebral route* of approach is more difficult than the three others, and is restricted to cases in which the distortion of the anatomic features of the base of the neck due to pathologic conditions contraindicate the supraclavicular route.

The *axillary route* does not give complete anesthesia of the entire upper extremity, because the injection is made at a level where the plexus begins to spread out and has already given off its posterior

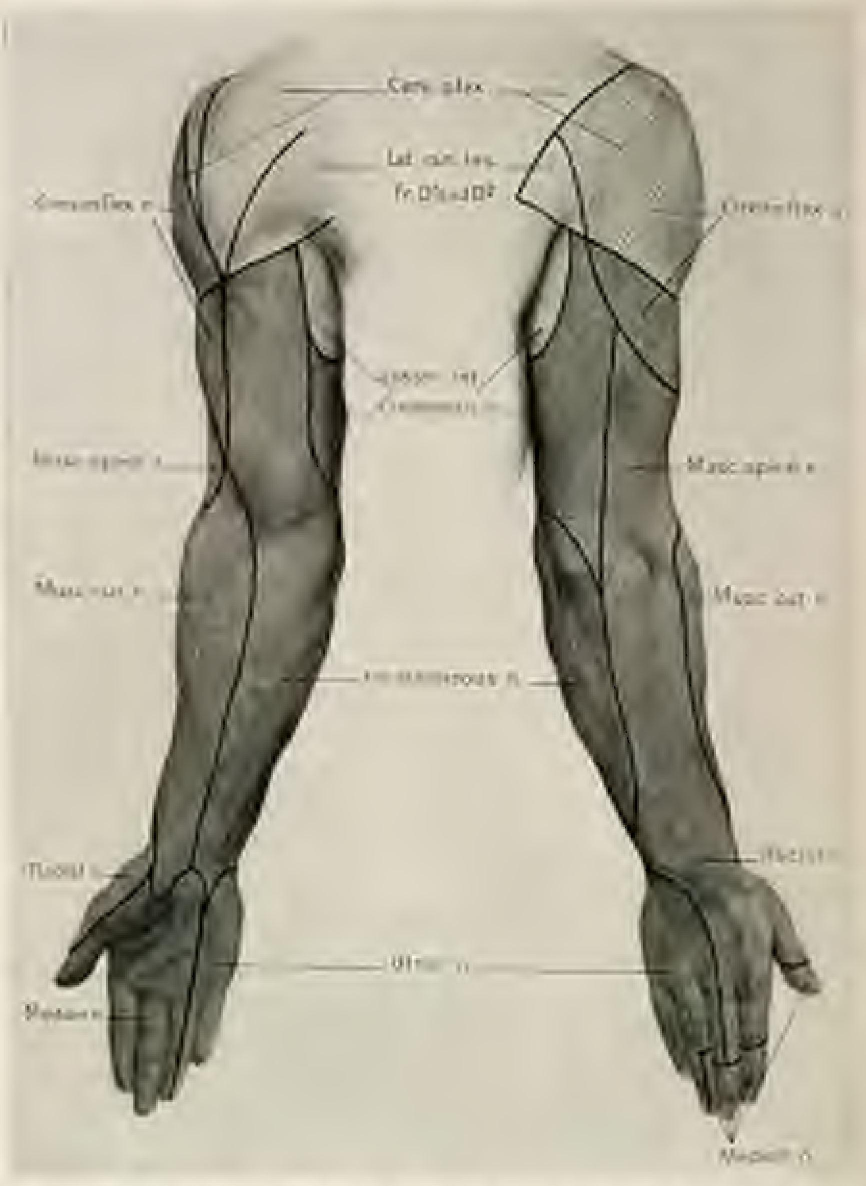

Fig. 160.—Brachial plexus block by the supraclavicular route: Dark area, Resulting zone of anesthesia; gray area, hypesthesia.

divisions. It needs, besides, great experience, owing to the number, size, and direction of the blood-vessels of the region. It is not advised to beginners; but will occasionally be found of great help to the experi-

enced man, in case of partial failure to block the plexus by the supraclavicular route, except for the radical operation of the carcinomatous breast, and other operations involving the axilla, of which the principal object is a clean dissection.

The *infraclavicular route* seems at first sight very accurate, because the needle is advanced along the plexus and the injection made above the clavicle; but it does not always give satisfactory results. The needle is, besides, advanced in a direction which is almost parallel to that of the blood-vessels, the technic being thus attended by risks almost similar to those alluded to when the axillary route was discussed. Gentleness must also be used for fear of breaking the needle when it is passed beneath the clavicle. It is, however, indicated in case of failure to block the plexus by the supraclavicular route, especially when it is desirable to keep the axilla free from edema or possible hematoma.

The *supraclavicular route* is unquestionably the safest and the most accurate, because of its simplicity and of the numerous reliable and fixed landmarks on which the technic is based. The four diagrams (Figs. 161 and 162) have been devised to help visualize these landmarks and thus facilitate the mental work of the beginner.

The brachial plexus block is the method of choice for all major operations on the upper extremity. The only contraindication to the method is the impossibility to reach the plexus, owing to pathologic conditions of the region. The author has no personal experience with the brachial plexus block in children, but he is under the impression that quite a number of them could be given the benefit of the method. The brachial plexus block is indicated for reduction of dislocation of the shoulder-joint, as well as that of the elbow-joint, reduction of fractures of the humerus or of the bones of the forearm, disarticulation of the shoulder, amputation of the arm, resection of the elbow, amputation of the forearm, sutures of nerves and tendons, radical amputation of the breast, and other operations involving the axilla.

Fig. 164.—Brachial plexus block by the supraclavicular route referred to the skeleton: a, Complete picture of the anatomic features which the anesthetist visualizes while facing directly the supraclavicular region, at about the level of the midpoint of the clavicle; b, the anesthetist momentarily forgets the existence of the pleura and takes care of the artery. After retracting the artery, the needle is introduced close to the tip of the index-finger which feels the beats of the artery, and advanced backward, downward, and inward toward the first rib.

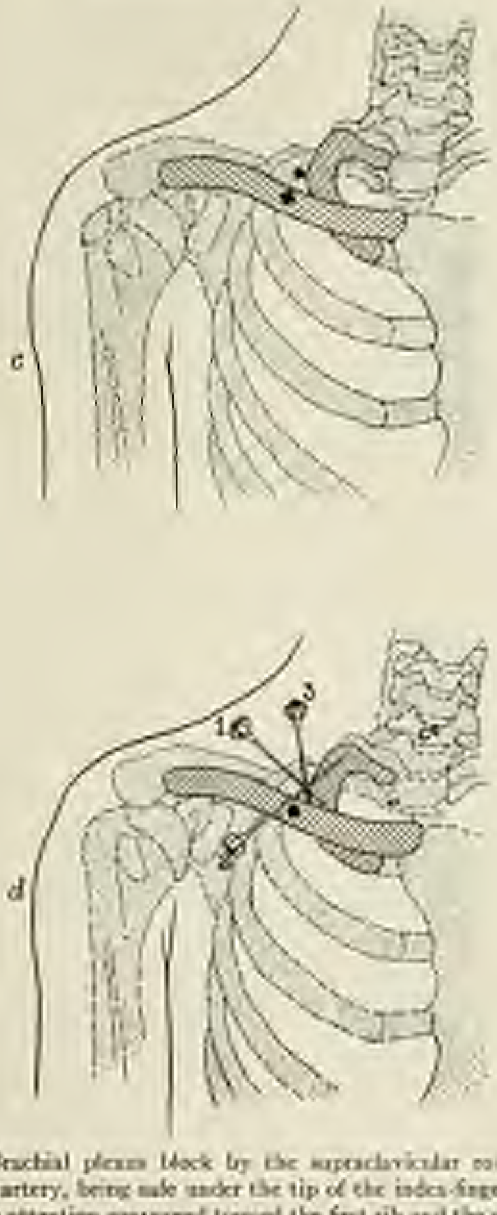

Fig. 162.—Brachial plexus block by the supraclavicular route referred to the skeleton: *c*, The artery, being safe under the tip of the index-finger, is now forgotten, leaving the whole attention converged toward the first rib and the clavicle at the costo-clavicular angle. The success of the operator depends on his ability to locate the first rib, thus avoiding the puncture of the pleural dome and first intercostal space; *d*, the same picture is present in the mind of the anesthetist during the three injections: 1 aims at the first rib; 2, at the tubercle of Chassaignac; 3, at the lateral border of the first rib behind the clavicle.

BLOCKING OF THE BRANCHES OF THE BRACHIAL PLEXUS

In certain cases it is found more convenient to block the branches of the plexus on their way to the periphery; in others to use the field-

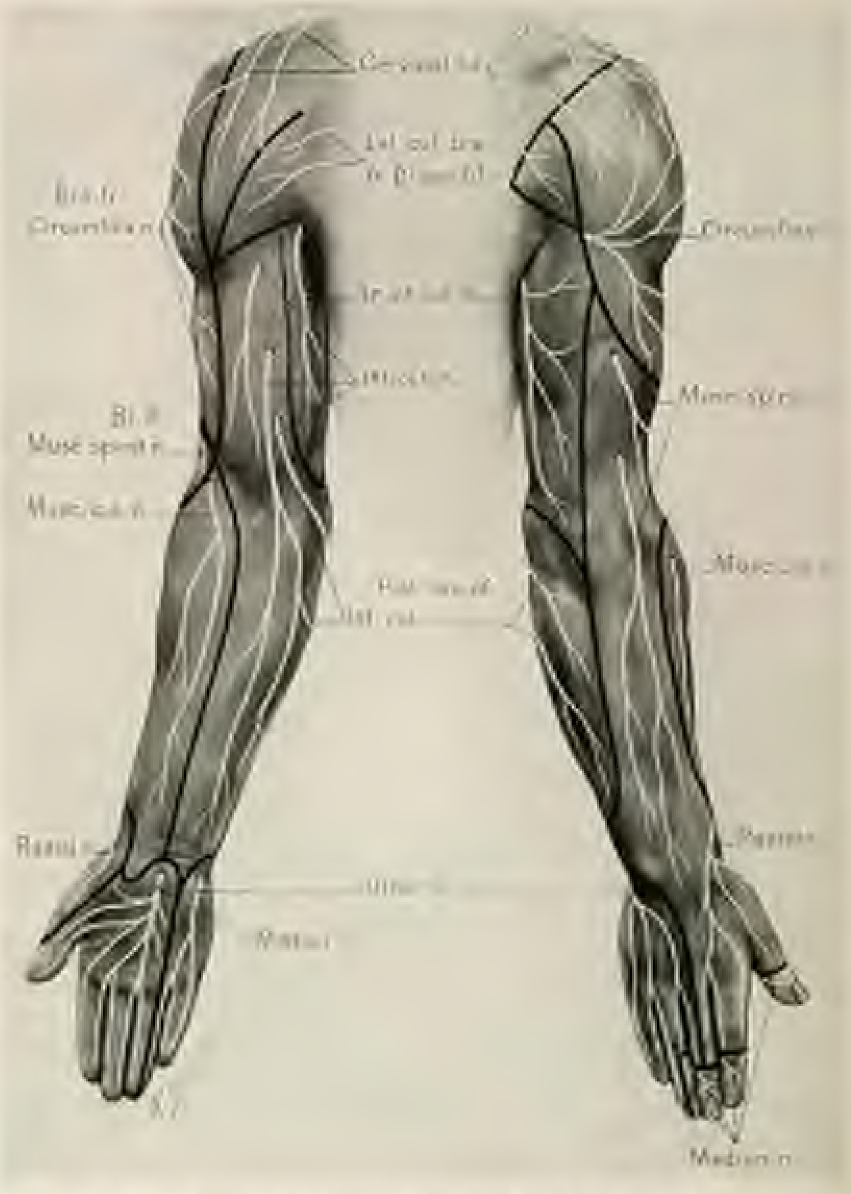

Fig. 163.—Sensory distribution of the branches of the brachial plexus.

block alone or associated with the nerve-block according to the needs of the particular case. Figure 163 illustrates the sensory distribution of the branches of the brachial plexus.

MEDIAN BLOCK

(Blocking of the Median Nerve)

The median nerve arises from the two cords formed by the union of the anterior divisions of the brachial plexus. These two cords, the inner and outer, unite in front or to the outer side of the axillary artery and form the two heads of the median nerve, which, thus formed, leaves the axilla and passes down the arm along with the brachial artery, lying first lateral to it, then to its inner side, after crossing obliquely the anterior aspect of the artery as the elbow is neared. It passes through the cubital fossa beneath the bicipital fascia and enters the forearm between the heads of the pronator radii teres muscle. On dipping beneath the bicipital fascia the median nerve passes almost midway between the internal condyle of the humerus and the inner side of the tendon of the biceps muscle (Fig. 164).

The median nerve continues its course in a straight line down the forearm between the flexor profundus digitorum and the flexor sublimis digitorum muscles and becomes superficial a little above the wrist, after contributing to the innervation of the flexor muscles of the forearm. It there lies beneath the deep fascia and corresponds to the interval between the tendons of the flexor carpi radialis and palmaris longus. After passing beneath the anterior annular ligament, it spreads out in the hand and contributes with the ulnar nerve to the innervation of the palmar region and part of the dorsal aspect of the index, middle, and ring fingers, occasionally the thumb.

The median nerve may be blocked at the elbow or at the wrist, according to the needs of the operation.

Median Block at the Elbow.—The *bend of the elbow* is determined by flexing the forearm on the arm, while the patient is in complete muscular relaxation, with a rigid probe or other thin instrument tightly held in the line of flexure. The forearm is then placed in extension, and the probe maintained in the position it occupied during flexion. The

Fig. 164.—The median nerve at the elbow and wrist. (After Hirschfeld and Léveillé.)

bend thus determined, which is higher than the line joining the condyles of the humerus, is traced on the skin by means of a sterile dermographic pencil or an applicator moistened with tincture of iodin.

The *tendon of the biceps* is then defined and its inner side marked on the first tracing. The tendon is easily felt in lean patients. In stout individuals it can be located by a simple device described by A. Broca in the following manner: The forearm is placed in 90 degrees flexion and the soft structures of the arm at the bend of the elbow deeply grasped and firmly held between the thumb and index-finger. When extension is restored to the forearm, while the hand is held in supination, the tendon of the biceps, which had been grasped owing to its

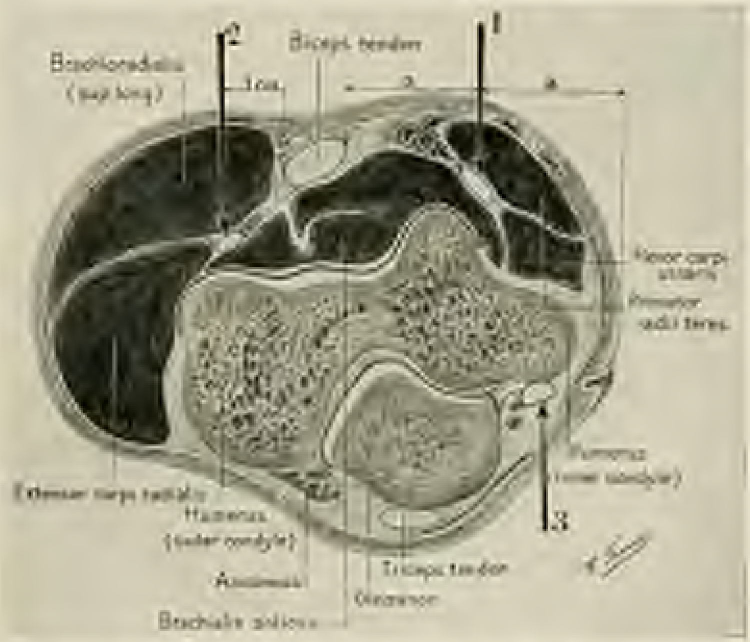

Fig. 165.—Cross-section of the left arm through the elbow (seen from above): 1, Median nerve; 2, musculospiral nerve; 3, ulnar nerve.

relaxed condition, suddenly escapes from the fingers, thus revealing itself.

With the patient lying on his back, arm placed in 90 degrees abduction and forearm in extension and supination, a wheal is raised midway between the medial aspect of the internal condyle and the inner side of the tendon of the biceps, at the bend of the elbow. Needle No. 2 (5 cm.) is inserted through the wheal and advanced past the skin, the superficial fascia and the deep fascia, in a direction perpen-

dicular to the surface of the skin. The nerve is approached gently and gradually; and, as soon as paresthesias are obtained, 3 c.c. of the 2 per cent. solution are injected without displacing the needle. It is sometimes necessary to push the needle a little deeper than the bicipital fascia and search for the nerve in an inward direction beneath the upper portion of the pronator radii teres muscle; the position of the nerve depending on the level at which the puncture is made, level which is itself subject to individual interpretations when defining the bend of the elbow. In the absence of radiating sensations, the injections are made fanwise beneath the deep fascia, across the path of the nerve, in the soft structures overlying the humerus, but nearer the skin than

Fig. 166.—Cross-section of the forearm at the wrist, passing through the styloid process of the ulna. The arrow points to the median nerve.

the bone. From 5 to 10 c.c. of the 2 per cent. solution is thus distributed at the bend of the elbow, and the region lightly massaged. About five minutes are necessary for the anesthesia to set in, when the nerve has not been touched by the needle. This is the average time taken to inject the other nerves at the elbow and infiltrate the supracondylar bracelet (page 316).

Median Block at the Wrist.—The styloid process of the ulna is defined by palpation and a line traced at that level across the anterior aspect of the wrist held in supination. The tendons of the palmaris longus and flexor carpi radialis are made salient, especially the former, by asking the patient to flex the wrist, while the anesthetist opposes

flexion. In very fat patients these tendons do not reveal themselves to the eye, as is the case in the average patients, but can be felt, like strings stretched side by side, along the axis of the forearm, rolling under the skin when the finger is passed across the region with a little pressure. If only one tendon is felt, it is that of the palmaris longus muscle.

With the patient's arm resting on a table or on a board passed under his shoulders across the operating table, the palm of the hand looking upward, a wheal is raised between the two tendons on the line already

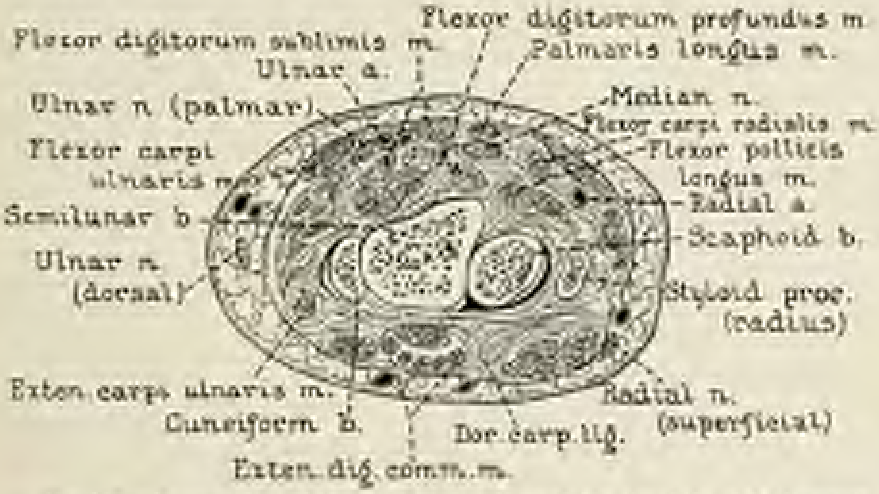

Fig. 167.—Cross-section of the wrist passing through the tip of the styloid process of the radius. It likewise passes through the carpal bones. The median and ulnar nerves occupy almost the same position as in Fig. 166, and may likewise be injected at that level, care being exercised not to inject the solution uselessly in the joint.

drawn across the wrist. If only one of the tendons (palmaris longus) has been defined, the wheal is raised on its outer side. Needle No. 2 (5 cm.), attached to the syringe which is held like a penholder, is inserted through the wheal and advanced in a direction perpendicular to the surface of the skin until its point has just passed the deep fascia. It is then gently and gradually introduced 0.5 cm. further, and if no paresthesias are signaled by the patient, 2 c.c. of the 2 per cent. solution are injected without moving. The needle is then partially withdrawn and reintroduced in a direction slightly inclined toward the tendon of the flexor carpi radialis, where injection is made of 2 c.c. of

the same solution. The median nerve often lies beneath that tendon at that level. The region is massaged as usual to hasten the diffusion of the injected fluid. In presence of radiating sensations the needle is stopped and the injection made without moving.

The median block is ordinarily associated with the musculospiral block and ulnar block for operations on the forearm, wrist, and hand.

MUSCULOSPIRAL BLOCK

(Blocking of the Musculospiral Nerve)

The musculospiral nerve is the larger of the two divisions of the posterior cord of the brachial plexus. It leaves the circumflex nerve, which is the other division, at about the level of the subscapularis muscle, passes behind the axillary artery, on the anterior aspect of the latissimus dorsi and teres major muscles, and turns downward, backward, and outward, entering the musculospiral groove between the heads of the triceps muscle. The musculospiral nerve reaches the lateral aspect of the arm, takes a forward course, crossing the humerus in close contact with the bone, at about 10 cm. above the external condyle, and enters the cleft between the brachioradialis and the brachialis anticus muscles (Fig. 165), after piercing the external intermuscular septum of the arm. It continues its course in that cleft on the anterior aspect of the humerus, and, on reaching the external condyle, divides into its terminal branches, the posterior interosseous and the radial nerves.

The *posterior interosseous nerve* passes through the substance of the supinator brevis muscle on its way to the lateral side of the radius, and, on reaching the posterior aspect of the forearm, passes between the two layers of the extensor muscles, to which it gives off numerous branches. It then continues its course, rapidly decreasing in size, and distributes its terminal twigs to the articular and bony structures of the dorsal portion of the wrist and hand, where they are joined by twigs from the ulnar nerve. The posterior interosseous nerve is chiefly a motor nerve.

The part taken by the musculospiral nerve in the sensory innervation of the dorsal aspect of the arm and forearm belongs to its inferior external cutaneous branch, given off while the nerve is still in the muscu-

lospiral groove, the dorsal aspect of the wrist and hand receiving its sensory nerve supply from the radial and ulnar nerves.

The *radial nerve* is purely sensory. From the external bicipital cleft of the elbow it passes down the radial side of the forearm, accompanied by the radial artery, under cover of the brachioradialis muscle. On reaching the lower third of the forearm it turns gradually backward, where it sends off diverging branches to the wrist, hand, and three outer digits. The musculospiral nerve brings, therefore, no contribution to the anterior aspect of the upper extremity.

The musculospiral nerve may be blocked at two levels, viz., on the lateral aspect of the humerus, as the nerve pierces the external intermuscular septum, that is, by the lateral route; and in the external bicipital cleft (between the brachioradialis and brachialis anticus muscles), that is, by the anterior route.

Lateral Route.—The external condyle of the humerus is defined by palpation and a wheal raised 10 cm. above it, along the axis of the lateral aspect of the arm. Needle No. 3 (8 cm.) is inserted through the wheal and advanced toward the lateral aspect of the humerus, where 15 c.c. of the 1 per cent. solution are distributed fanwise close to the bone along a line measuring from 6 to 8 cm. The needle is first introduced in a direction perpendicular to the surface of the skin, then partially withdrawn and reintroduced more and more obliquely, each time discharging part of the syringe when the needle impinges on the bone, until a distance of from 3 to 4 cm. has been reached, up and down on each side of the point at which the needle first came in contact with the bone. If radiating sensations are induced, especially in the dorsal aspect of the hand, while injecting fanwise, the needle should be stopped and the contents of the syringe discharged without moving.

Anterior Route.—The bend of the elbow and the tendon of the biceps are defined in the manner described (page 203) for the median block. In fact, the musculospiral block is almost always associated with the median block and ulnar block, so that the line marking the bend of the elbow serves for the injection of the three nerves. A wheal is raised on that line about 1 cm. lateral to the tendon of the biceps (Fig. 168), and needle No. 2 (5 cm.) inserted through the wheal in a direction perpen-

dicular to the surface of the skin and gently advanced toward the index-finger of the left hand placed on the posterior aspect of the external condyle of the humerus, until the point of the needle comes in contact with the bone. If paresthesias are obtained, injection is made of 5 c.c. of the 2 per cent. solution without displacing the needle; if not, the solution is distributed transversely on the anterior surface of the con-

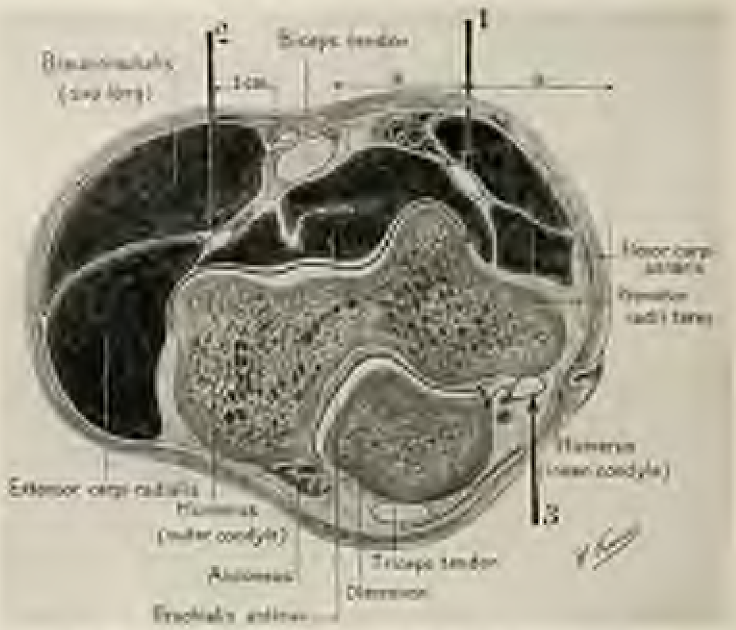

Fig. 168.—The musculospiral block at the elbow (arrow 2).

dyle close to the bone as well as in the soft structures in its immediate neighborhood.

ULNAR BLOCK

(Blocking of the Ulnar Nerve)

The ulnar nerve arises from the inner cord of the brachial plexus and pursues a downward course in front of the triceps and to the inner side of the brachial artery. At about the middle of the arm it pierces or passes over the inner margin of the internal intermuscular septum, follows an inward and backward direction, and reaches the interval between the internal condyle of the humerus and the olecranon, where

it becomes so superficial that one can feel it rolling under the finger beneath the deep fascia. It then passes between the heads of the flexor carpi ulnaris muscle, reaches the anterior aspect of the forearm, and follows a straight course to the wrist and hand. In the forearm it supplies filaments to the flexor carpi ulnaris and contributes to the innervation of the flexor profundus digitorum by sending filaments to its ulnar half. On reaching the wrist the ulnar nerve becomes more superficial, lying to the outer side of the tendon of the flexor carpi ulnaris,

Fig. 169.—The ulnar block at the elbow. Note the direction of the needle.

occasionally partly covered by the tendon (Fig. 164). It passes to the outer side of the pisiform bone and enters the hand, where it divides into its terminal branches.

At about the middle of the forearm the ulnar nerve gives off its dorsal branch to the hand, which passes backward and downward round the ulna and splits into three branches for the fingers, after sending off a branch to the dorsum of the wrist. Figure 163 gives a sufficient illustration of the sensory distribution of the ulnar nerve for the purposes of the present technic.

Ulnar Block at the Elbow.—With the patient lying in the recumbent lateral position, on the side opposite the one to be injected, and the arm to be injected resting alongside of the body, the groove between the internal condyle of the humerus and the olecranon (epitrochleo-olecranian groove) is defined by palpation. Just above the groove the ulnar nerve is located and firmly held with the overlying structures between the thumb and index-finger of the left hand, to prevent it from moving. Needle No. 2 (5 cm.), connected with the syringe containing 3 c.c. of the 2 per cent. solution, is inserted through a wheal raised at the summit of the fold thus produced, and is advanced toward the nerve in a direction almost parallel with it.

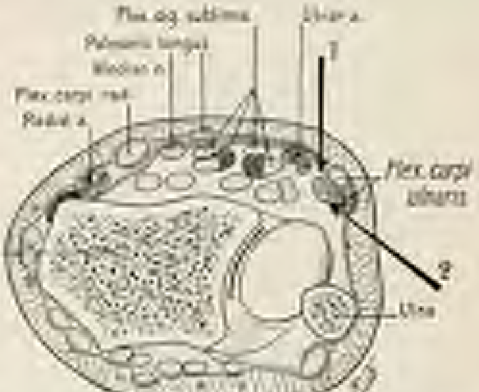

Fig. 170.—Ulnar block at the wrist: 1, Anterior route; 2, lateral route.

As soon as paresthesias are obtained the solution is injected without moving. Intraneural injection is here rendered easy, since the nerve is held in position while it is approached by the point of the needle. But, as already stated, paraneural injections are sufficient for surgical purposes, provided the anesthetic fluid is deposited beneath the deep fascia in close proximity to the nerve.

In a few cases the ulnar nerve is an occupant of the epitrochleo-olecranian groove only in the position of extension of the forearm, passing in front of the internal condyle as soon as the forearm is flexed. The nerve should, therefore, be searched for, grasped, and injected while the forearm is in extension.

Ulnar Block at the Wrist.—With the hand of the patient held in

supination, the tendon of the flexor carpi ulnaris is defined, by palpation, at the level of the styloid process of the ulna, and a wheal raised on the radial side of the tendon. This site of puncture is on the same

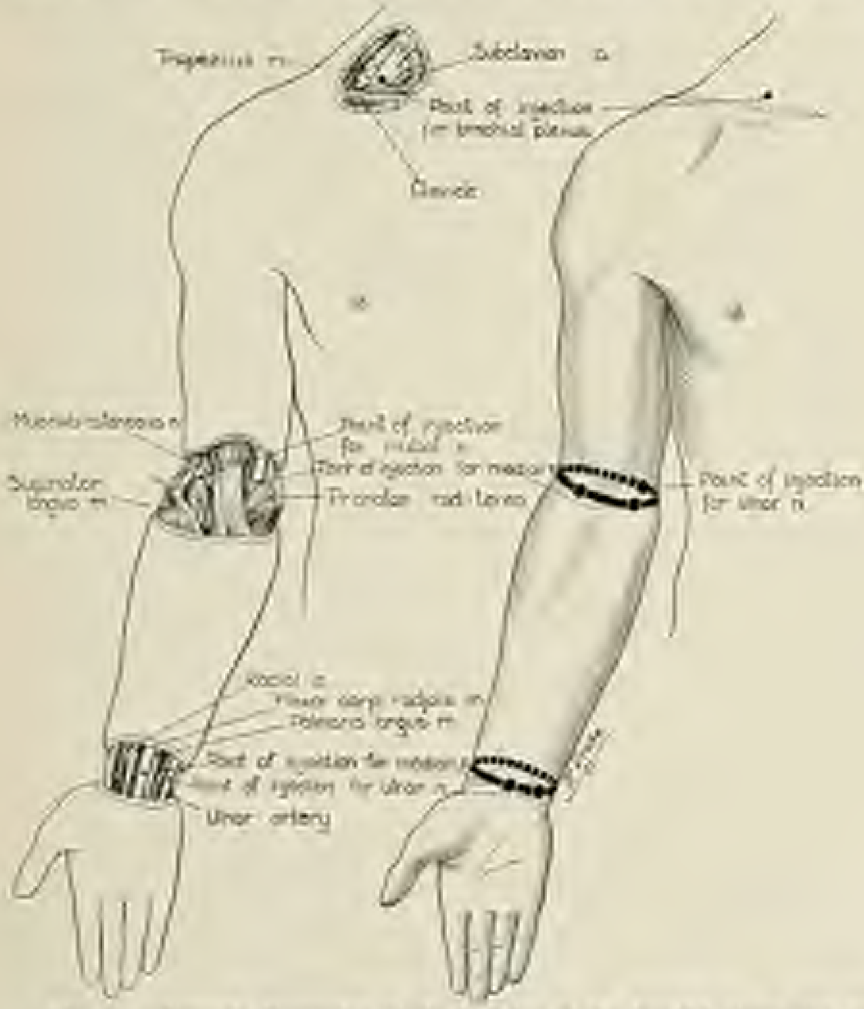

Fig. 171.—Synoptic illustration of the blocking of the brachial plexus and its branches. The supracondylar or the wrist bracelet, as the case may be, completes the anesthesia of the desired segment.

level as that for the median block. Needle No. 2 (5 cm.) or the intradermal wheal needle, according to the weight of the patient, is inserted through the wheal and advanced tangentially to the tendon in a direction perpendicular to the surface of the skin (Fig. 170). If no pares-

thesias are obtained soon after the point of the needle has passed the deep fascia the shaft of the needle is swung a little outward and the needle advanced about 0.5 cm. behind the tendon, where 5 c.c. of the 2 per cent. solution are injected. It is preferable for this block to try to induce paresthesias, because the solution is very often injected within the sheath of the tendon and therefore does not diffuse to the nerve. The ulnar nerve may also be reached by inserting the needle on the ulnar side of the tendon of the flexor carpi ulnaris, just above the styloid process of the ulna and advancing it beneath the tendon, passing tangentially to it. This procedure is exceptionally resorted to.

The ulnar block at the elbow is useful in operations on the ulnar margin of the hand and the little finger. Associated with the median block and musculospiral block it is indicated in operations on the forearm, wrist, and hand, provided a ring of subcutaneous infiltration is made around the arm to block the sensory nerve supply of the skin originating from branches given off above the site of puncture, as well as from the independent sensory nerves, musculocutaneous and internal cutaneous.

The ulnar block at the wrist associated with the median block and a ring of subcutaneous and subfascial infiltration around the forearm is indicated for operations on the hand.

Paravertebral Dorsal Block

(Blocking of the Dorsal or Thoracic Nerves)

Each dorsal or thoracic nerve emerges from its intervertebral foramen, giving off a meningeal or recurrent branch which is distributed to the vertebræ and their ligaments and to the blood-vessels of the vertebral canal, spinal cord, and its membranes. The trunk then separates into two branches, called the anterior and posterior primary divisions.

The *posterior primary division* turns backward and divides into an internal and an external branch, which supply the muscles and integuments of the back.

The *anterior primary division* immediately gives off the ramus

communicans to the sympathetic system and enters the intercostal space between the external and internal intercostal muscles, both of which it supplies. It continues its course around the thorax, in the intercostal space, and emerges almost on the midline of the thorax or the abdomen, where it terminates in supplying the skin of that region. On the axillary side of the trunk a lateral cutaneous branch is given

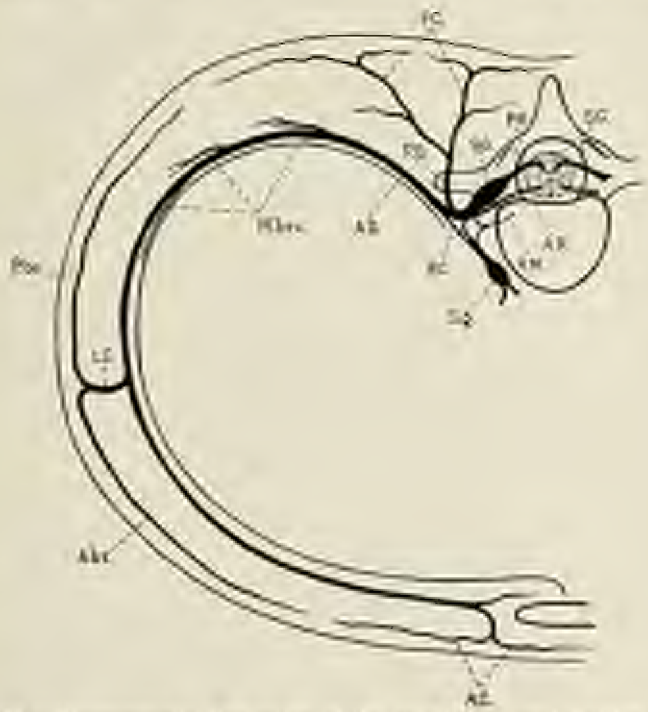

Fig. 172.—Diagrammatic illustration of the constitution and division of a dorsal or thoracic nerve: *S.C.*, Spinal cord; *P.R.*, posterior root; *A.R.*, anterior root; *S.G.*, spinal ganglion; *S.g.*, sympathetic ganglion; *R.M.*, recurrent meningeal; *R.C.*, ramus communicans; *A.D.*, anterior division; *P.D.*, posterior division; *P.C.*, posterior cutaneous; *L.C.*, lateral cutaneous; *A.C.*, anterior cutaneous; *M.brs.*, muscular branches; *P.br.*, posterior branch; *A.br.*, anterior branch.

off which pierces the external intercostal muscle and divides into two branches, a posterior and an anterior, which supply the skin of the lateral portion of the trunk (Fig. 172).

The five upper thoracic nerves supply by their cutaneous branches the lateral aspect of the breast as far as the nipple. They continue their course forward and, after piercing the external intercostal fascia,

and the pectoralis major muscle, distribute their terminal branches to the mammary gland and pectoral integument. The lower thoracic nerves pass forward in the abdominal wall between the digitations of the diaphragm. They continue their course between the internal oblique and transversalis muscles, and on reaching the lateral margin of the rectus muscle (semilunar line) pierce the rectus sheath, supply the rectus muscle, and follow an inward course through the muscle close to its posterior aspect. After supplying the rectus muscle they become superficial near the linea alba and send off their terminal branches to the skin of that region.

Certain peculiarities differentiate from each other the first, second, occasionally the third, and the twelfth thoracic nerves. The first thoracic nerve largely contributes fibers to the brachial plexus. The posterior ramus of the lateral cutaneous branch of the second thoracic nerve, called the intercostohumeral nerve, is quite large; it pierces the inner wall of the axilla between the second and third ribs, and joins the internal cutaneous branch of the brachial plexus, after crossing the axilla. The third thoracic nerve, occasionally the fourth, sends off a contribution to the internal cutaneous nerve. The twelfth thoracic nerve contributes fibers to the lumbar plexus and gives off a lateral cutaneous branch which is not confined in its distribution to the abdominal wall, but pierces the internal oblique muscle, sends a filament to the lower digitation of the external oblique muscle, which it penetrates at a point from 2 to 10 cm. above the iliac crest, and supplies the integument of the gluteal region as far as the great trochanter. The seventh, eighth, and ninth thoracic nerves supply the abdominal wall above the umbilicus; the tenth is distributed to the region of the umbilicus and the eleventh and twelfth supply the area between the umbilicus and the pubis.

The thoracic nerves are blocked from a point of puncture 3 to 4 cm. distant from the line of the spinous processes, that is, from the midline of the back. It is, therefore, necessary to have a thorough knowledge of the anatomy of the region so as to be able to visualize its structures while attempting to reach the nerves at their exit from the intervertebral foramina. The relation which any thoracic nerve bears

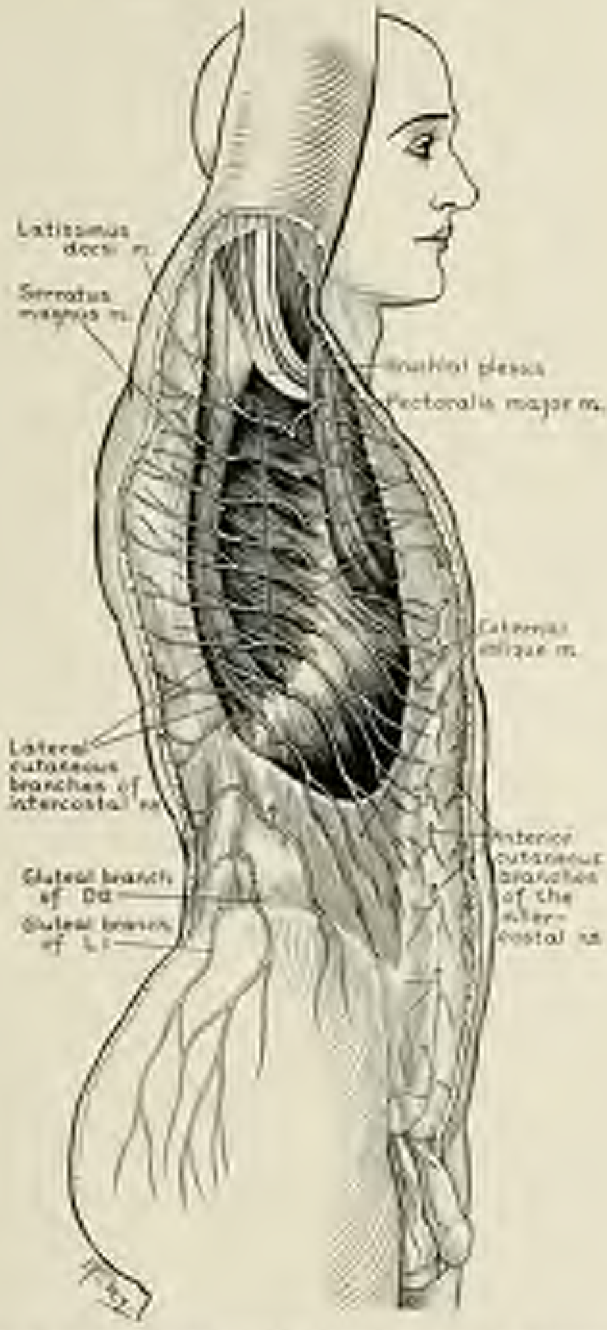

Fig. 173.—Lateral cutaneous branches of the thoracic nerves. A subcutaneous injection made along *AB* affects only the posterior divisions of these branches.

to the elements of the deep structures within which it lies on its way from the intervertebral foramen to the costal angle is of major impor-

Fig. 174.—Paravertebral dorsal block. The seventh thoracic nerve exposed at its site of injection. The arrow shows the direction of the needle.

tance. On emerging from the intervertebral foramen the *thoracic nerve* lies midway between the transverse processes of two adjacent vertebræ, runs obliquely across the intercostal space toward the angle

of the rib above it, and enters the subcostal groove. During its course from the intervertebral foramen to the angle of the rib the thoracic nerve is accompanied by the thoracic artery and vein which lie immediately above it.

The *external intercostal muscle*, with its fibers running downward and outward, is stretched across the intercostal space and extends from the tubercle of the ribs outward, with little or no aponeurotic attachment to the spine; while the *internal intercostal muscle*, with its fibers running downward and inward, stops at about the level of the costal angle and is continued by a thin aponeurosis, called the internal intercostal fascia, which extends inward to the tubercle of the ribs. The thoracic nerve, therefore, is separated from the pleural cavity and lungs only by the thin internal intercostal fascia, while it is, in the region under consideration, deeply situated beneath the longitudinal muscles of the back and the external intercostal muscle (Figs. 174 and 175). These anatomic features are of great importance and must be remembered while making injections in the dorsal region, since it is between the external intercostal muscle and the internal intercostal fascia that the solution must be deposited to block the thoracic nerves.

Landmarks.—The superficial landmarks are the spinous processes of the vertebræ and the ribs at the level of their angle, especially in lean patients. The deep landmarks are the ribs and transverse processes, too deeply situated to be palpated, but which serve as reliable guides for the needle.

Technic No. 1.—With the patient lying on the side opposite the one to be injected, back arched, face and knees brought together so as to widen the intercostal spaces, and a cushion under the loin to straighten the vertebral column and obtain complete muscular relaxation, the spinous process of the twelfth dorsal vertebra is defined as follows: The twelfth rib is defined by palpation and its direction traced on the skin, as well as the midline of the spinous processes. The perpendicular measuring 5 cm., dropped from the twelfth rib on the midline of the back, marks the spinous process of the twelfth dorsal vertebra (Fig. 176). A wheal is raised over it, serving as a landmark. The other spinous processes are reckoned from the twelfth. On a line parallel

with, and 4 cm. distant from the midline, wheals are raised opposite the selected spinous processes, thus marking the various sites of puncture. Needle No. 3 (8 cm.) is inserted through the wheal and advanced

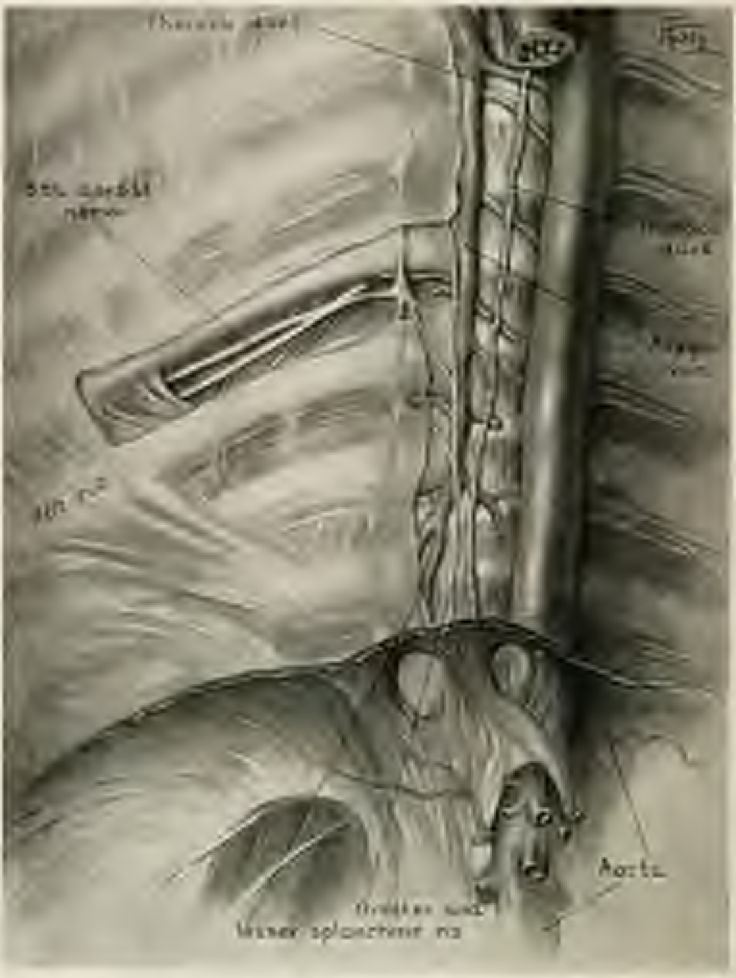

Fig. 175.—Anterior aspect of the posterior wall of the thoracic cavity, illustrating the thinness of the structures separating the thoracic nerves from the pleural cavity. A window in the parietal pleura and the internal intercostal fascia has been opened to expose the eighth dorsal nerve.

in a direction perpendicular to the surface of the skin toward the posterior surface of the rib just above the intercostal space to be injected. After taking contact with the rib the needle is slightly drawn back to

change its direction; its hub is then inclined 45 degrees outward and upward (Fig. 177) and the needle reintroduced downward and inward toward the lower border of the rib, which is reached at different depths varying in different individuals and according to the height of the puncture in the same patient. The needle is finally advanced in the

Fig. 176.—Landmarks of the dorsal vertebræ. With the arms alongside the body, the horizontal line passing through the spine of the scapulæ marks the spinous process of the third dorsal vertebra; that drawn at the level of their inferior angle passes between the seventh and eighth dorsal spines. The perpendicular measuring 5 cm., dropped from the twelfth rib on the midline of the back, marks the spinous process of the twelfth dorsal vertebra.

same direction 2 cm. further than the lower border of the rib. The direction of the needle is thus downward, inward, and frontward, across the intercostal space, and its point buried between the intercostal muscles, half-way between the two ribs and about 1 cm. in front of the transverse processes. The syringe is then connected with the needle and the injection made of 5 or 6 c.c. of the 1 per cent. solution.

Half of the anesthetic fluid is injected without moving, the rest being distributed with a little to-and-fro motion while the needle is being withdrawn. But the syringe must have been completely discharged when the point of the needle reaches the level of the lower border of the rib. Care should be exercised when moving the needle to and fro (*a*) not to change its direction, (*b*) not to displace it more than 2 cm., and (*c*) not to approach the spine closer than when the injection was first started. These recommendations also apply to Technic No. 2.

Fig. 177.—Paravertebral dorsal block.

Technic No. 2.—After taking the landmarks as for the preceding technic and raising the wheals in their correct places, needle No. 5 (8 cm.) is inserted through the wheals in succession and advanced toward the spine in a direction making an angle of about 25 degrees with the sagittal plane of the body. The needle travels in a horizontal plane, passing between the ribs and transverse processes, and impinges on the body of the vertebra just in front of the intervertebral foramen (Fig. 178). It is then slightly drawn back and injection made of from

5 to 6 c.c. of the 1 per cent. solution while the needle is moved a little to and fro.

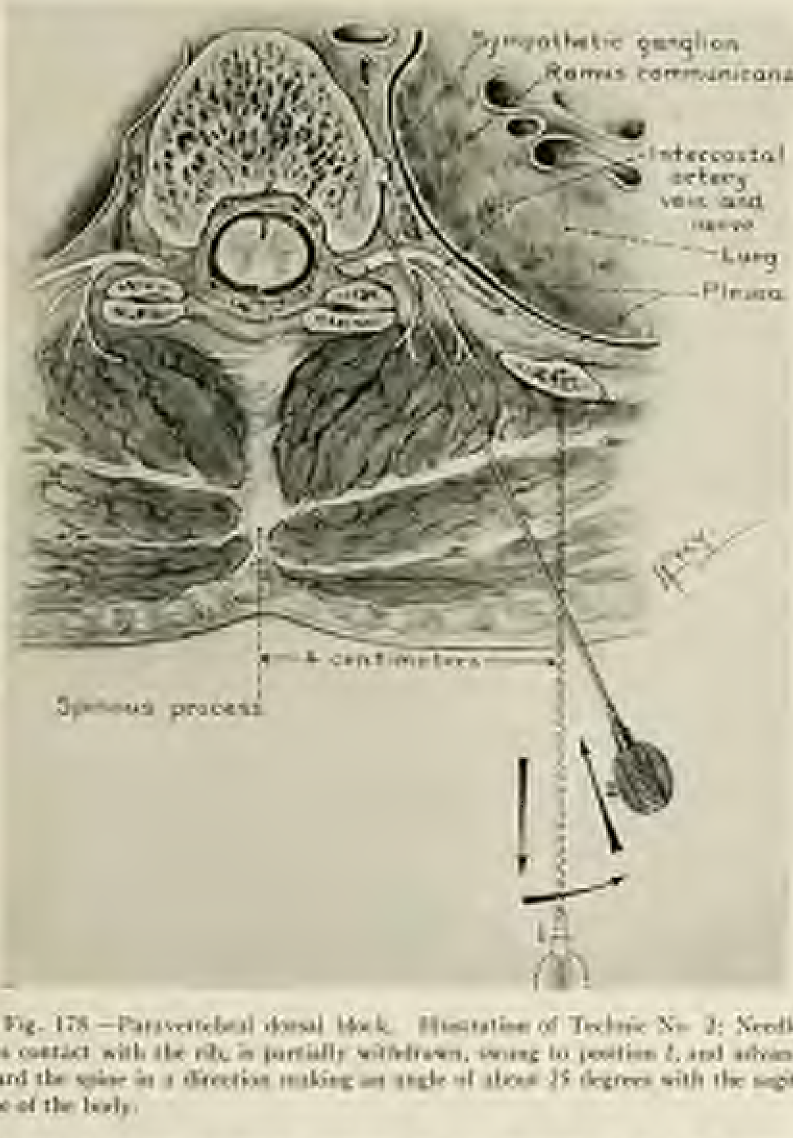

Fig. 178.—Paravertebral dorsal block. Illustration of Technic No. 2: Needle 1 takes contact with the rib, is partially withdrawn, swung to position 2, and advanced toward the spine in a direction making an angle of about 25 degrees with the sagittal plane of the body.

After injecting as many nerves as are required for the intended operation the operative field is tested with a needle by comparing the stimuli registered by the cutaneous territory of the injected nerves with those referred to the homologous territory on the opposite side.

If the stimuli along the path of one or two of the nerves are painful, supplementary injections should be made with greater care. But if the whole area injected does not seem to have been anesthetized, more time should be allowed and the test renewed. Failure on the part of the patient to give accurate answers does not always mean absence of anesthesia, since pressure and touch are occasionally interpreted as pain (page 9). The casual injection of an inert solution may also be the cause of such failure.

Indications.—Paravertebral dorsal block is indicated in all operations on the thorax and the upper abdomen.

It is associated with the brachial plexus block in operations on the upper extremities and the axilla, and for radical amputation of the breast; with paravertebral lumbar block for operations on the abdominal organs, kidney, and ureter.

Practical Considerations.—*Landmarks.*—In puncturing a given intercostal space at 4 cm. from the midline of the back it is customary to name that space, consequently, the thoracic nerve contained in it, by the name of the spinous process which faces it. Ex.: The space opposite the spinous process of the sixth dorsal vertebra is ordinarily called the sixth intercostal space. However, the spinous processes of the dorsal vertebræ are not the natural pointers to their homologous nerves or intercostal spaces. As a matter of fact, the spinous processes of the dorsal vertebræ increase in length and slope more and more downward while passing from the upper to the lower portion of the spine. Some of them, especially from the fourth to the ninth, are so inclined downward and backward that they point either to the rib or to the intercostal space below. Occasionally a spinous process points to the second intercostal space below it, so that, if these anatomic dispositions are overlooked in taking the superficial landmarks, the nerve injected from a point opposite the nth spinous process may be the $(n + 1)$th or the $(n + 2)$th, according to the height at which the puncture is made (Fig. 179). In every case, however, the field is tested after making the injections, and if the blocked area does not prove sufficiently wide for the intended operation, or if one of the nerves has not been reached by the anesthetic fluid, supplementary injections are made.

In the majority of cases it is easy to define by palpation the spinous processes of the dorsal vertebræ, but it is often difficult to name any one of them with sufficient accuracy. In the erect position, arms

Fig. 179.—The spinous processes of the dorsal vertebræ in relation to the intercostal spaces

lying vertically along the trunk, the line joining the spines of the scapulæ passes through the spinous process of the third dorsal vertebra, and the line joining the lower angle of the same bones marks the seventh

process or passes between the seventh and eighth; but, with the patient lying on either side, back arched and arms forward and flexed, as in the sleeping position, these landmarks are not always reliable, owing to the displacement of the scapulæ. The author has thus been led to start from a fixed landmark, which is the twelfth rib. If the twelfth rib is palpated and its direction toward the spine traced on the skin, the perpendicular measuring 5 cm., dropped from this rib on the midline, marks the spinous process of the twelfth dorsal vertebra (Fig. 176). In counting the spinous processes above the twelfth, one can easily name any one of them, and therefore locate with some accuracy the correct intercostal space and the nerve it contains.

Technic.—Numerous procedures have been described for blocking the dorsal nerves at their exit from the intervertebral foramina (Läwen, Finsterer, Kappis, Pauchet-Sourdat, Kroenig-Siegel, and many others). They all tend to reach the nerves either close to the spine or at a little distance from it. Sometimes the needle is introduced between two transverse processes, occasionally passing above the transverse process, or the rib corresponding to the vertebra. More frequently the needle, after taking contact with a rib, passes below its lower border or the corresponding costotransverse articulation, and is advanced in the direction of the nerve. The distance from the midline varies from 3 to 4 cm., according to the procedure used. The direction given to the needle varies with the distance of the site of puncture from the midline, and many authors recommend that the needle be introduced in a direction making an angle of from 20 to 25 degrees with the sagittal plane of the body. All these procedures may be valuable in the hands of the men who devised them. In fact, success in the paravertebral method greatly depends on the experience of the operator and the skill with which he uses a single procedure. Each one has a modus operandi to suit his personal convenience.

The safest and most convenient way of making paraneural injections of a thoracic nerve, with the object of blocking at the same time the ramus communicans to the sympathetic chain, seems to be that in which the needle is introduced at a distance of 4 cm. from the midline and advanced downward, inward, and frontward toward the spine,

in a direction making an angle of about 45 degrees with the surface of the skin at the site of puncture (Fig. 174). Its direction thus crosses the intercostal space, consequently the thoracic nerve, very obliquely; and if the needle is moved a little to and fro while injecting continuously the fluid diffuses in the intercostal space, between the intercostal muscles, with greater facility than when the space is approached in a horizontal plane. The edema is thus likely to extend from the spine to the site of puncture, soaking both anterior and posterior primary divisions of the nerve, as well as the ramus communicans which lies close to the spine. There is, besides, little risk, if any, of puncturing the pleural cavity or the lung, which seems to be the chief objection expressed by some of the men who have tried paravertebral injections. The point of the needle is more likely to impinge on the rib below the intercostal space, or pass beneath it, advancing toward the spine, if it is introduced too deeply in the direction commanded by the angle of 45 degrees which the shaft of the needle makes with the surface of the skin.

Puncture.—When the needle is inserted through the wheal raised opposite one of the spinous processes, at a distance of 4 cm. from the midline of the back, and advanced in a direction perpendicular to the surface of the skin, it may either pass through the intercostal space or impinge on a rib, which may be the one above or that below the space.

If the needle passes through the intercostal space there is nothing to guide its point toward the nerve to be blocked. If it happens to hit the nerve lying in the punctured space, injection is at once made without moving, and the territory of the radiating sensations carefully noted, although with relative accuracy. But if at a depth of from 3 to 4 cm. from the surface of the skin no bony contact is felt or paresthesias induced, the needle is partially withdrawn and reintroduced obliquely upward, then downward, in order to locate the rib which is the chief deep landmark (Fig. 180). If the needle comes in contact with the lower border of the rib above the space it should not be advanced further below that rib, since it would be deviating from the nerve which lies in the middle of the space; but contact with the lower rib should be taken, so as to inject the nerve below, carefully noting which nerve

is now being injected (Fig. 181). The most favorable condition is that in which the needle impinges on the upper margin of the rib below the space punctured and is directed downward toward the nerve lying in the space below it (Figs. 181, 182). If the site of puncture dose not agree with the requirements of such a condition, it is not necessary to pass the needle through another point of entrance, since the mobility of the skin of the back facilitates the displacement of the needle, *provided*

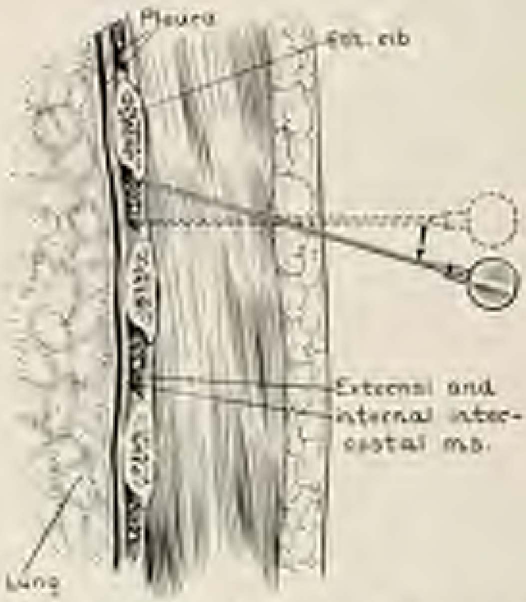

Fig. 180.—Paravertebral dorsal block. If the needle happens to pass between two ribs, it should be withdrawn and reintroduced in another direction, seeking contact with one of the ribs. Here the needle deviates from the nerve.

the needle has been drawn back until its point lies in the subcutaneous tissue before the skin is moved. The point of the needle can thus be made to overlie the upper margin of the rib below or that of the rib above the punctured intercostal space.

It is hardly necessary to point out the impossibility of introducing the needle into the spine through the intervertebral foramen, when the needle is inserted at a distance of 4 cm. from the midline of the back. When injecting in the upper thoracic region it occasionally happens, however, that cerebrospinal fluid comes out of the needle, although the

impression is that the needle has not been advanced deep enough to reach the subarachnoid space. There is, besides, no sign that the nerve has been approached by the point of the needle on its way through the intervertebral foramen. The only explanation of this condition is an abnormal prolongation of the subarachnoid culdesac accompanying the nerve beyond the intervertebral foramen. If the needle is intro-

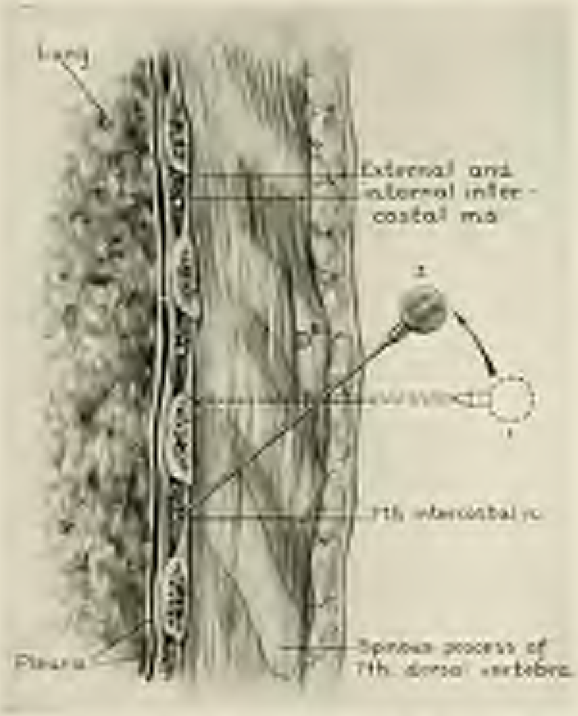

Fig. 131.—Paravertebral dorsal block. The needle inserted opposite the spinous process of D^6 impinges on the upper margin of the rib below the sixth intercostal space and passes below the rib in the direction of the seventh intercostal nerve.

duced unattached to the syringe, a reasonable time allowed before connecting it with the syringe, and the aspiration test made and renewed, there is no risk of making intraspinal injections during the paravertebral manipulations. The flow of cerebrospinal fluid prompts the immediate gradual withdrawal of the needle until the flow ceases.

On the other hand, it is possible to pass the needle through the ligamenta subflava, while injecting very close to the laminæ for laminectomy,

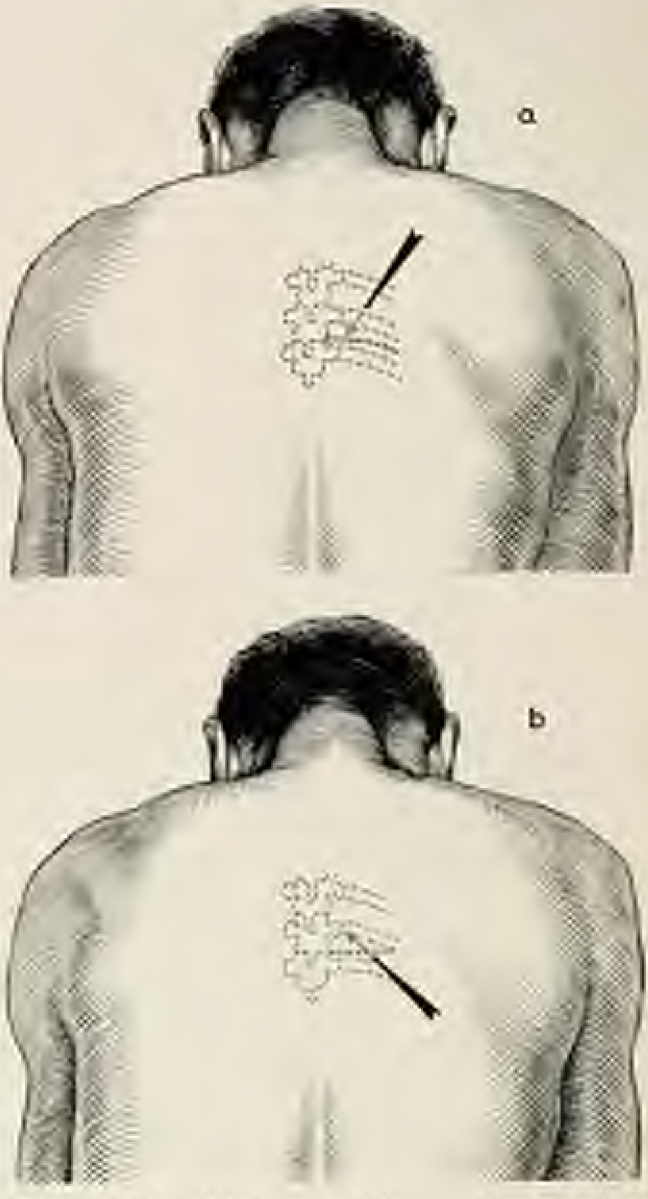

Fig. 182.—Paravertebral dorsal block: *a*, Good direction of needle; *b*, bad direction.

and reach the epidural space or the subarachnoid space, injecting the solution into these cavities. At times the presence of an epidural hematoma is the undeniable proof of the puncture of the ligamenta

subflava. Such mishap can be avoided by injecting between the transverse processes, thus keeping away from the laminæ.

One of the intercostal blood-vessels may be punctured, as shown by the flow of blood from the lumen of the needle. Such a mishap is not always due to poor technic, since it also occurs in the hands of the more experienced, but to the peculiarity of the anatomy of the region. It prompts the slight withdrawal of the needle until the flow ceases and a change in its direction if the needle must be introduced more deeply. A small hematoma thus created by the point of a fine needle has no clinical significance, as already stated, but occasionally dilutes the injected fluid and interferes with the anesthesia. The sudden and sharp pain which at times follows the injection and coincides with flow of blood is probably due to the injection beneath the visceral pleura, with consequent irritation of the parietal pleura.

The puncture of the pleural cavity is of no importance, it is not even noticed; but injection within it induces coughing. Paravertebral injections should, therefore, be made very slowly, drop by drop, on starting. If the patient begins to cough, the needle is slightly withdrawn and the injection stopped for a few seconds until the cough ceases. The injection is resumed gently and slowly, and may be continued without any worry if no more coughing is induced.

The puncture of the lung is of no importance. It is occasionally followed by a flow of blood from the needle. The injection of the anesthetic fluid into the lung is immediately signaled by the patient as a bitter taste and suggests the withdrawal of the needle. But the injection beneath the visceral pleura may pass unperceived, until the appearance of a sudden and sharp pain a few minutes after the injection. There is, as stated before, little risk, if any, of puncturing the lung if the direction of the needle is obliquely downward, inward, and frontward as advised in Technic 1 described on page 219.

Injection.—The injection of from 5 to 6 c.c. of 1 per cent. novocain-adrenalin solution gives the most satisfactory results. The 2 per cent. solution, if injected in quantities equal to the 1 per cent., would certainly be too toxic and occasionally prove fatal; the injection of smaller quantities to be successful must be made within the nerve sheath or at

least in its close proximity, but the resulting anesthesia is of shorter duration. The 0.5 per cent. solution, as used by Kroenig and Siegel, must be injected in larger volumes (15 c.c. for each nerve), thus creating undesirable extensive edemas beneath the parietal pleura. The action of the anesthetic drug is, besides, less rapid and the duration of anesthesia shorter.

It has been inferred that injection should not be made in too close proximity to the vertebral column, because of toxic symptoms due to the diffusion of the anesthetic fluid within the spine (Kappis). When caudal or epidural injections of colored solutions (China ink, methylene-blue, eosin) are made within the sacral canal, the fluid diffuses up in the epidural space, occasionally as far as the occipital foramen; but never is the solution found within the dura, nor is it possible to find any trace of the injected fluid outside the spine except in the sacral region (Cathelin, Thompson, and others). This is conclusive with regard to the impermeability of the dura, as well as of the fibrous ligaments (Charpy) stretched across the intervertebral foramen, extending from the nerve sheath to the margin of the foramen. Injections made close to the spine are perhaps more toxic than those made a little distance from it, because of the more rapid absorption of the fluid by the extraspinal venous plexuses, apart from the fact that one of the veins of these plexuses may be punctured without the anesthetist's knowledge, if the aspiration test is not made and renewed now and again. In order to reduce to a minimum the induction of such toxic symptoms it is advisable to make paravertebral injections at a distance of about 1 cm. from the spine, and, above all, to make sure that the injection is not made into the blood-stream.

Anesthesia.—The anesthesia following the injection of only one thoracic nerve is illusory, since the cutaneous branches of the adjacent nerves overlap the intercostal space supplied by that nerve; and unless the anesthetic fluid is distributed subcutaneously along the intercostal space, or injection made of at least one nerve above and one nerve below that space, there will always be pain or tenderness. Besides, the dorsal branches of the thoracic nerves supplying the skin slope downward and outward, overlapping at times adjacent territories, and it occasionally

happens that these branches are not reached by the paravertebral injections made in the usual manner. To make sure that they are the actual cause of pain or tenderness in a region where the injections made

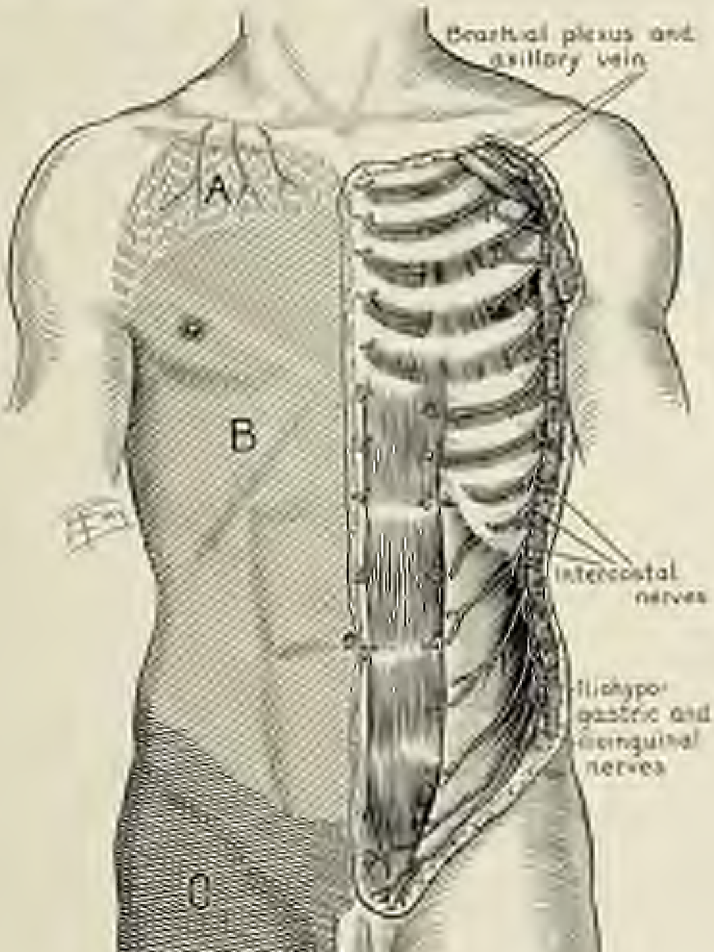

Fig. 183.—Distribution of the sensory nerves of the trunk: *A*, Hypesthesia due to the cervical nerves; *B*, territory of the dorsal nerves; *C*, that of the lumbar nerves.

were expected to produce absolute anesthesia, a transverse subcutaneous line of infiltration is made through the uppermost site of puncture used for the paravertebral injections and the region tested again.

In front, the anesthesia produced by paravertebral injections does not extend to the midline, but stops at about an inch from it, thus leaving a narrow band of hypesthesia due to overlapping nerve filaments from the opposite side. It is sufficient to distribute the solution subcutaneously along the midline to complete the anesthesia.

In the upper thoracic region the superficial cervical nerves overlap the territory of the first three or four dorsal nerves (Fig. 183), and give a zone of hypesthesia which can easily be controlled by subcutaneous injections around the base of the neck. This sensory distribution of the cervical nerves should be remembered especially when inducing anesthesia for high laminectomy and radical amputation of the breast.

Paravertebral Lumbar Block

(Blocking of the Lumbar Plexus)

The lumbar plexus is formed by the union of the anterior primary divisions of the *first four lumbar* nerves into a series of oblique loops lying in the substance of the psoas magnus muscle. It receives a contribution from the twelfth thoracic nerve, occasionally one from the fifth lumbar nerve.

The anterior primary division of the *first lumbar nerve* on leaving the intervertebral foramen inosculates with branches from the twelfth thoracic and second lumbar nerves, and quickly divides into two branches, the *iliohypogastric* and the *ilio-inguinal*. Both of them pierce the psoas magnus muscle anterior to the transverse process of the first or second lumbar vertebra and run below and parallel with the twelfth thoracic nerve, between the parietal peritoneum and the quadratus lumborum muscle. A little beyond the lateral margin of that muscle the *iliohypogastric* nerve pierces the transversalis muscle and continues its course toward the iliac crest, beneath the internal oblique muscle, while the *ilio-inguinal* nerve remains subperitoneal as far as the anterior superior iliac spine, where it pierces the transversalis muscle and meets the iliohypogastric nerve, with which it forms an inosculation.

Iliohypogastric Nerve.—At about the middle of the iliac crest the iliohypogastric nerve gives off a branch (iliac) which pierces the internal

and external oblique muscles and is distributed to the integument covering the anterior gluteal region and the tensor fasciæ femoris. It then continues its course, like the twelfth thoracic nerve with which it inosculates, and distributes its terminal filaments to the suprapubic region. On approaching the internal inguinal ring the hypogastric branch of the iliohypogastric nerve gives off a branch which enters the inguinal canal, follows the anterior surface of the spermatic cord, and, on reaching the external inguinal ring, divides into pubic and scrotal filaments in men, pubic and labial (labia majora) in women. This branch may be absent, in which case the iliohypogastric nerve gradually places itself between the internal and external oblique muscles, on nearing the internal inguinal ring, and becomes an occupant of the inguinal canal, lying on the anterior surface of the spermatic cord, up to the external inguinal ring, where it breaks up into its terminal filaments supplying the integument of the suprapubic region.

Ilio-inguinal Nerve.—After inosculating with the iliohypogastric nerve near the anterior superior iliac spine the ilio-inguinal nerve enters the inguinal canal on the anterior aspect of the spermatic cord, continues its course to the external inguinal ring, and distributes its terminal branches to the upper inner portion of the thigh, the pubic region and scrotum, or the mons veneris and labia majora.

The anterior primary division of the *second lumbar nerve*, after receiving contributions from the first and third lumbar nerves, divides into two branches, viz., the *genitocrural* and the *external cutaneous*.

Genitocrural Nerve.—The genitocrural nerve traverses obliquely downward and outward the psoas magnus muscle close to the second lumbar vertebra and emerges on the anterior surface of the muscle, opposite the body of the third lumbar vertebra. It then reaches the common iliac artery which it follows up to its division, then crosses the external iliac artery and, at the level of the internal inguinal ring, divides into two branches, the genital and the crural. The *genital branch* passes into the inguinal canal, follows the posterior aspect of the spermatic cord, emerges from the external inguinal ring, and is distributed to the scrotum and to the integument of the thigh adjacent to the scrotum. In women it follows the round ligament and is dis-

tributed to the labium majus. The *crural branch* runs downward to Poupart's ligament, beneath which it passes, and is distributed to the upper anterior portion of the thigh. Sometimes the genitocrural nerve divides into its genital and crural branches very high near its emergence,

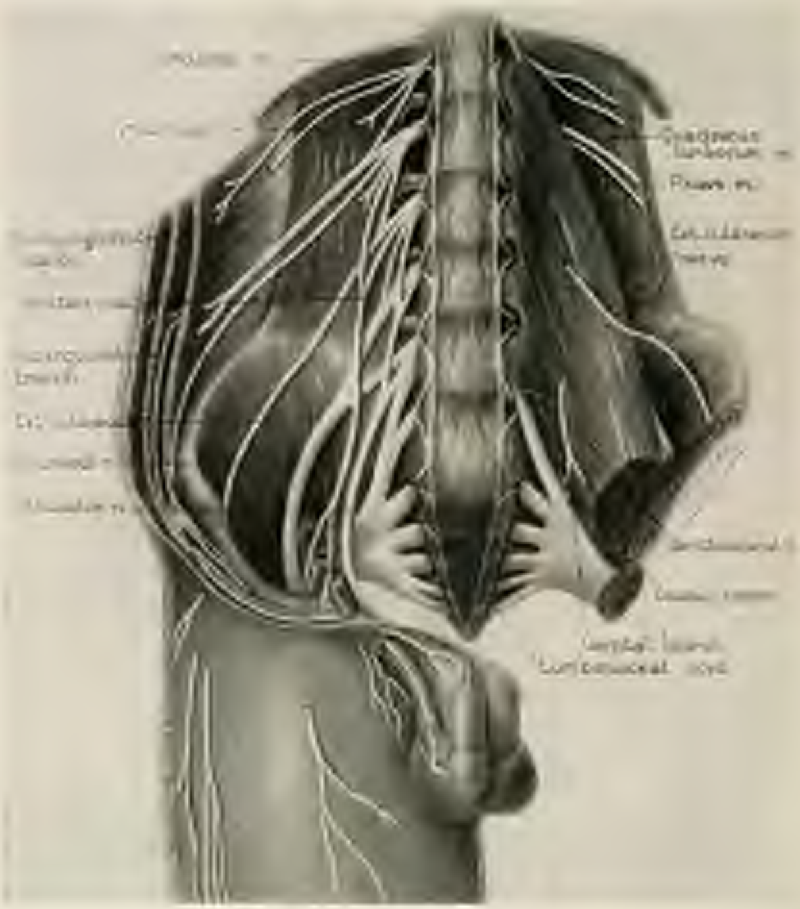

Fig. 184.—The lumbar plexus.

both running parallel to each other along the inner edge of the psoas muscle.

External Cutaneous Nerve.—The external cutaneous nerve runs down the lateral margin of the psoas magnus muscle and reaches the iliac fossa, where it lies over the iliac muscle, covered by the iliac fascia.

It passes beneath Poupart's ligament, medial to the anterior superior iliac spine, and is distributed to the integument of the lateral portion of the thigh. The external cutaneous nerve often arises from the third lumbar nerve.

The anterior primary division of the *third lumbar nerve* and the two contributions sent to it by the second and fourth lumbar nerves pass obliquely downward and outward behind the psoas magnus muscle and meet at the lateral margin of the muscle to form the *anterior crural* or femoral nerve, the largest branch of the lumbar plexus. The anterior crural nerve, therefore, emerges from beneath the lateral margin of the psoas magnus muscle; it thence follows a downward course in the groove between the psoas and iliac muscles, covered by the iliac fascia, passes beneath Poupart's ligament lateral to the femoral artery, and becomes an occupant of the thigh. A little below Poupart's ligament it breaks up into its terminal branches (page 247).

The anterior primary division of the *fourth lumbar nerve* splits into two branches of unequal size. The thinner receives contributions from the second, third, and occasionally the fifth lumbar nerves, which all unite in the substance of the psoas magnus muscle to form the *obturator nerve*. The larger portion of the fourth lumbar nerve joins the fifth lumbar nerve and contributes to form the *lumbosacral cord*. The obturator nerve passes vertically downward and emerges from the inner margin of the psoas magnus muscle opposite the brim of the true pelvis. It continues its course along the anterolateral wall of the pelvis, below the iliopectineal line, upon the inner surface of the pelvis fascia, leaves the pelvis through the obturator canal, and divides into its terminal branches, which are separated from each other by the obturator externus muscle and later by the adductor brevis muscle. These branches supply the adductor muscles, the hip- and knee-joints, and the integument of the medial aspect of the thigh. Sometimes a filament is given off which inosculates with the saphenous internus or its accessory.

The anterior primary division of the *fifth lumbar nerve* receives the major portion of the fourth lumbar nerve and forms the *lumbosacral cord*, which contributes to the formation of the sacral plexus.

The foregoing description of the lumbar plexus brings out the following important practical considerations:

1. The lumbar plexus is deeply situated in the substance of the psoas magnus muscle. Its branches, in pursuing their course toward

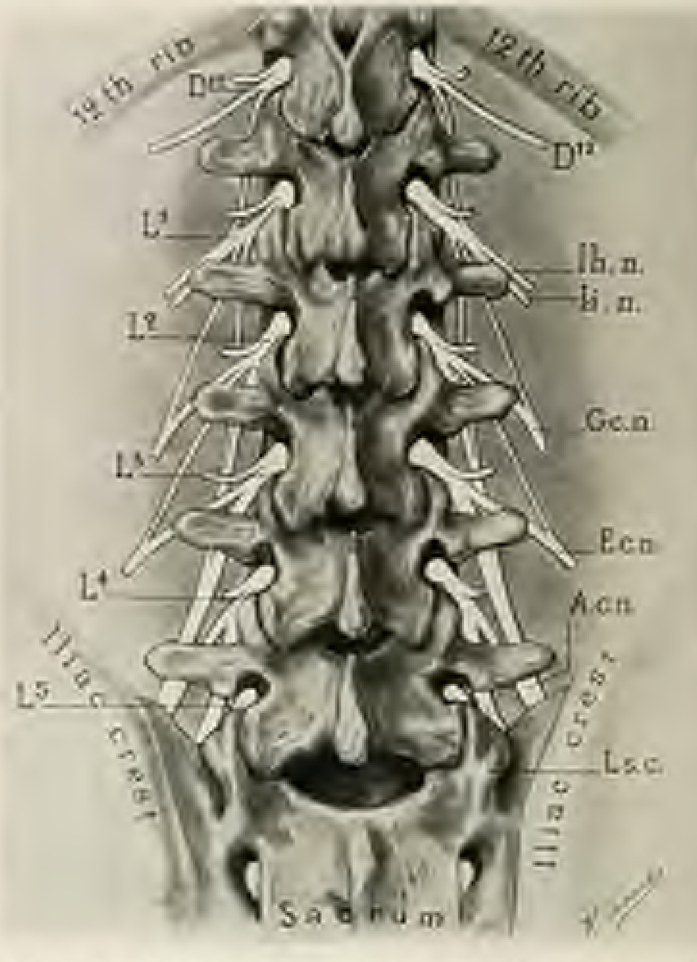

Fig. 185.—The lumbar nerves in relation to the spine: *Ih.n.*, iliohypogastric nerve; *I-i.n.*, ilio-inguinal nerve; *Gc.n.*, genitocrural nerve; *E.c.n.*, external cutaneous nerve; *A.c.n.*, anterior crural nerve; *L.s.c.*, lumbosacral cord.

the periphery, become more and more remote from the surface of the back, which is the site of election for the injection of the spinal nerves by the paravertebral route. But the lumbar nerves, with the exception

of the first, slope more or less sharply downward and outward as soon as they emerge from the intervertebral foramina, crossing obliquely the anterior aspect of the transverse processes (Fig. 185). They are, therefore, accessible close to the spine.

2. The iliohypogastric and ilio-inguinal nerves are given off close to the vertebral column. They run almost parallel with the twelfth

Fig. 186.—The external cutaneous, anterior crural, and obturator nerves at their exit from the pelvis.

thoracic nerve and reach the anterior superior iliac spine side by side, between the transversalis and internal oblique muscles. These nerves can, therefore, be blocked by injecting their common trunk, the first lumbar nerve, near its exit from the intervertebral foramen, or by infiltrating the nerves themselves near the anterior superior spine of the ilium.

3. The multiple origins of the branches of the lumbar plexus render it difficult, not to say impossible, to block with sufficient accuracy any particular branch of the plexus exclusive of the others, by distributing the solution close to the spine; but these branches become superficial, consequently accessible, on emerging from the pelvis, and can thus be reached individually.

(*a*) The genitocrural nerve becomes superficial on reaching the anterior abdominal wall, at the internal inguinal ring.

(*b*) The external cutaneous nerve leaves the pelvis beneath Poupart's ligament and crosses the margin of the iliac bone medial to the anterior superior iliac spine. It therefore lies, at that level, in the superficial layers overlying the bone.

(*c*) The anterior crural nerve passes beneath Poupart's ligament lateral to the femoral artery, from which it is separated by the iliac fascia.

(*d*) The obturator nerve leaves the pelvis through the obturator foramen and is a little more deeply situated than the other branches of the plexus.

4. Three branches of the plexus become at a certain time occupants of the inguinal canal, viz., (1) the iliohypogastric nerve itself or its inguinal branch, (2) the ilio-inguinal nerve, and (3) the genital branch of the genitocrural nerve.

5. The suprapubic region and the external genitalia are partly supplied by the lumbar plexus.

6. The branches of the lumbar plexus are destined chiefly for the lower extremities.

Landmarks.—The superficial landmarks are the spinous processes of the lumbar vertebræ; the deep landmarks, their transverse processes.

Technic.—With the patient lying on the side opposite the one to be injected, the spinous processes of the lumbar vertebræ are defined (page 244), and wheals are raised opposite the upper edge of the spinous processes, on a line 3 cm. distant from and parallel to the midline of the back. Needle No. 3 (8 cm.) or No. 4 (10 cm.), according to the weight of the patient, is inserted through each of these wheals in succession and advanced frontward, in a direction perpendicular to the surface of the skin, until its point impinges on the transverse processes.

at a depth of from 4 to 5 cm. The direction of the needle is slightly modified, upward or downward, if the bone is not felt at that depth. The needle is then partially withdrawn and reintroduced a little upward and inward toward the spine, in a direction making an angle of about 25 degrees with the sagittal plane of the body. After taking contact with the same transverse process, the needle is passed tangentially to its upper margin and advanced 3 cm. further. If paresthesias are induced, which is the rule in this region, injection is immediately made of from 7 to 8 c.c. of the 1 per cent. solution without moving. If not, the solution is distributed in front of the transverse process, while the needle is moved a little to and fro in the same direction. Ten minutes are allowed before the operation is begun.

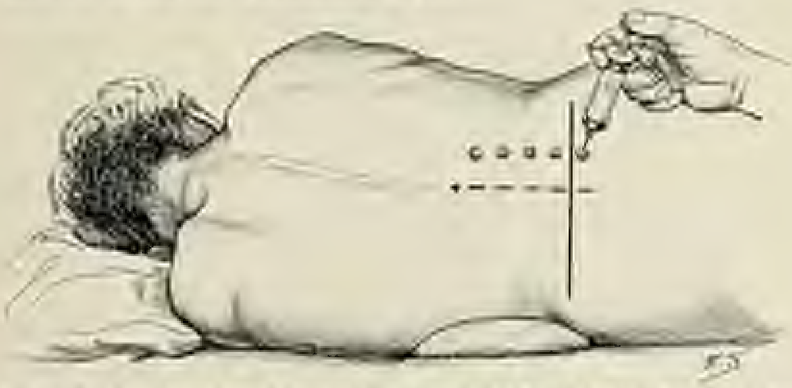

Fig. 157.—Lumbar plexus block. Blocking of the fourth lumbar nerve: + marks the spinous process of D^{12}, below which the lumbar spines are traced. The line crossing these indicates the highest points of the iliac crests.

Indications.—Paravertebral lumbar block is seldom used alone. It is ordinarily associated with the paravertebral dorsal block for operations on the kidney and ureter and on the abdominal organs; with the sacral block, for operations on the pelvic organs. Associated with the injection of L^5, S^1, and S^2 it may be used for operations on the lower extremities, in case it is impossible to induce spinal anesthesia.

Practical Considerations.—*Landmarks.*—The spinous processes of the lumbar vertebræ are blades of moderate thickness lying in the sagittal plane of the body. They do not slope downward and backward like the dorsal spines; their upper and lower edges are almost horizontal,

their posterior edge vertical (Fig. 188). Their average thickness is from 0.5 to 1 cm.; their height around 2 cm.; and their depth, that is, the distance between their free posterior edge and their attachment to the vertebral laminæ, measures from 3 to 4 cm. When looking from the

Fig. 188.—Side view of the lumbar spine, showing the shape and direction of the spinous processes.

back, the spinous processes of the lumbar vertebræ lie opposite the intertransverse spaces, that is, if two horizontal lines be drawn tangent to the upper and lower edges of the spinous process of any lumbar vertebra, these lines pass through the transverse processes of two adjacent

vertebræ, the upper transverse process belonging to the vertebra under consideration (Fig. 189). For this reason the transverse processes are best approached from sites of puncture opposite the upper edge of

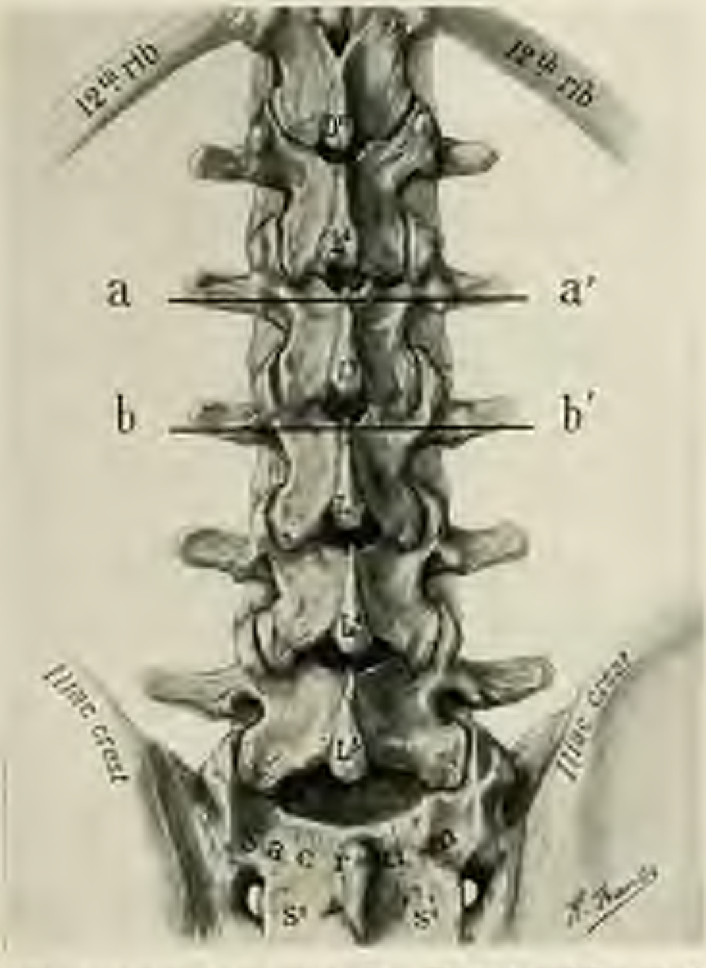

Fig. 189.—Back view of the lumbar spine. The horizontal lines aa', bb', drawn tangent on the upper edge of L^2 and L^3, mark the transverse processes of these vertebræ. The space between the two lines is the second lumbar space, which is the site of injection of the second lumbar nerve.

the spinous processes. The transverse processes of the lumbar vertebræ are ordinarily short and thin. They are, therefore, approached from points of puncture not farther than 3 cm. from the midline of the back, and located with great tactile delicacy. The average depth of the trans-

verse processes beneath the skin surface is 5 cm., but variations exist according to the weight of the patient. The fourth and fifth transverse processes are more deeply situated.

In very lean patients the spinous processes of the lumbar vertebræ are so prominent that they can be recognized by sight, the twelfth

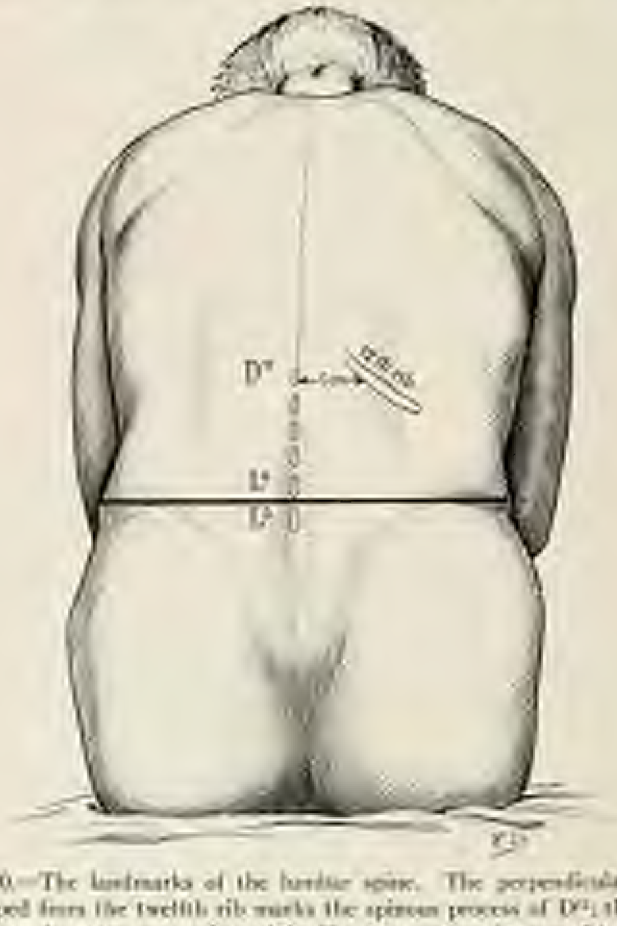

Fig. 190.—The landmarks of the lumbar spine. The perpendicular measuring 5 cm. dropped from the twelfth rib marks the spinous process of D^{12}; the horizontal line tangent to the uppermost points of the iliac crests passes between L^4 and L^5.

dorsal spine being oval, while the lumbar spines are rectilinear prominences. The depressions between them are very well marked. These features gradually disappear, while the weight of the patient increases. But their exact knowledge greatly facilitates the work of the anesthetist and renders it less difficult to differentiate the lumbar spines from

the dorsal spines when palpating the dorsolumbar region. In some patients it is necessary to control in the following manner the findings gathered by palpation: After tracing on the skin the posterior edges of the lumbar spines, with as much accuracy as possible, the direction of the twelfth rib is likewise reproduced on the skin. The perpendicular measuring 5 cm. dropped from that rib on the midline of the back marks the spinous process of D^{12}. The line tangent to the uppermost point of the iliac crests passes through L^4 or between L^4 and L^5 (Fig. 190). In very stout patients the midline of the back is a deep groove in which one can hardly feel anything through the thickness of the

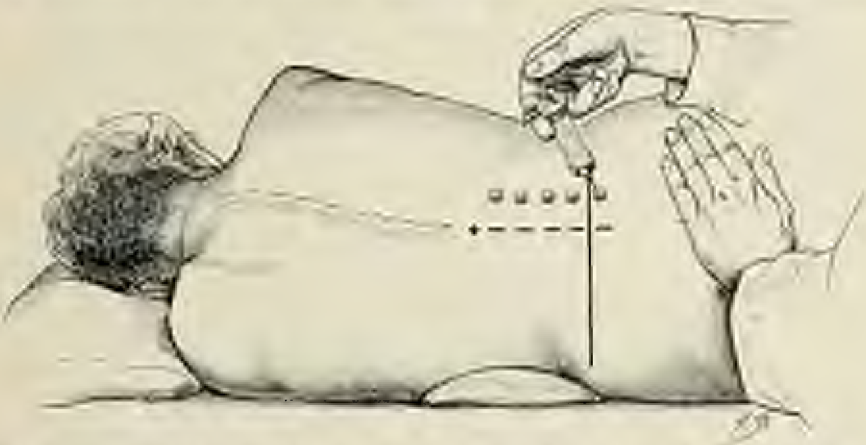

Fig. 191.—Blocking of the fifth lumbar nerve. Note the direction of the needle. (See Fig. 187.)

overlying structures, and the iliac crests are so padded with fat that it is hardly possible to define them with sufficient accuracy. In some cases the spinous processes are defined by rubbing the index-finger slowly down the midline of the back from the dorsal spine to the sacrum. The stimulations transmitted to the palpating finger arise from the depressions felt, the interval between two consecutive depressions being taken as the height of a spinous process. In exceptional cases fortunately, the presence of these depressions is revealed by a peculiar tactile sense acquired by experience much more than from actual findings: it is a sort of guesswork, acceptable for intraspinal block, but not for paravertebral block, in which the accuracy of the various sites of

puncture solely depends on the accuracy with which the spinous processes have been defined.

Injection.—When the needle is passed over the transverse process of L^1, the injection reaches the twelfth thoracic nerve. In using the same technic from L^1 to L^5, the fifth lumbar nerve will not be injected unless the needle be passed beneath the transverse process of L^5 (Fig. 191).

The induction of paresthesias is the rule in this region, owing to the size of the nerve trunks and to their sharp slanting position in the immediate vicinity of the spine. The needle must, therefore, be advanced gently and gradually toward the nerve, as soon as it has passed the transverse process, so that it may be stopped in due time if its point happens to come in contact with the nerve to be blocked. The induction of paresthesias must be avoided, because multiple or repeated punctures of large nerve trunks often lead to shock by nervous exhaustion.

In case of bilateral block the patient is asked to change side, and the whole procedure repeated on the opposite side.

Blocking of the Branches of the Lumbar Plexus

EXTERNAL CUTANEOUS BLOCK

(Blocking of the External Cutaneous Nerve)

From the iliac fossa the external cutaneous nerve enters the thigh beneath Poupart's ligament, medial to the anterior superior spine of the ilium. It then crosses or passes through the tendinous origin of the sartorius muscle, follows a downward course beneath the fascia lata, from which it emerges at a point from 12 to 15 cm. below the anterior superior iliac spine. At that level, or a little above, it gives off a posterior branch, which breaks up into numerous filaments distributed to the integument covering the tensor fasciæ femoris and the lower portion of the gluteal region. Continuing its course downward in the subcutaneous tissue, the external cutaneous nerve gives off numerous collateral branches, which supply the skin overlying the iliotibial band, and extends to the knee, where it participates in the formation of the patellar plexus.

Technic.—With the patient lying in the recumbent dorsal posi-

tion, the anterior superior iliac spine is defined by palpation and a wheal raised one fingerbreadth (1.5 cm.) below and medial to it. Needle No. 2 (5 cm.), previously connected with the syringe, is introduced through the wheal and advanced in a direction perpendicular to the surface of the skin, until its point comes in contact with the margin of the iliac bone, where 10 c.c. of the 1 per cent. solution are distributed fanwise along that margin, on a length of about 5 cm. from the anterior superior iliac spine, in a direction parallel with Poupart's ligament. The solution is injected continuously while the direction of the needle is changed, thus distributing the solution subfascially as well as subcutaneously. The resulting edema is lightly massaged, so as to help the diffusion of the injected fluid.

Indications.—The external cutaneous block is indicated for superficial operations on the lateral aspect of the thigh, especially for levying skin-grafts. A wider field of anesthesia is secured by associating it with the anterior crural block. But its chief indication is the anesthesia of the lower extremity, in which case it is associated with the blocking of the other nerves supplying that region of the body.

ANTERIOR CRURAL BLOCK

(Blocking of the Anterior Crural Nerve)

The anterior crural or femoral nerve emerges from the pelvis beneath Poupart's ligament and becomes an occupant of the thigh. At Poupart's ligament it lies lateral to the femoral artery, beneath the iliac fascia, very often a little deeper in the substance of the iliac muscle. As soon as it reaches Poupart's ligament or a little below it the anterior crural nerve divides into superficial and deep branches.

The deep branches are chiefly motor in function. They supply the rectus femoris, the vastus externus, the vastus internus, the crureus and the subcrureus, give off articular filaments to the hip- and knee-joints, and the internal saphenous nerve.

The internal or long saphenous nerve enters Hunter's canal at the apex of Scarpa's triangle and accompanies the femoral vessels as far as the opening in the adductor magnus muscle, where it gives off its

infrapatellar branch, which inosculates with the internal, the middle, and the external cutaneous nerve to form the patellar plexus. It then pierces the anterior wall of Hunter's canal, passes between the vastus internus and the adductor magnus, and becomes superficial on the inner side of the knee by piercing the deep fascia. The internal saphenous nerve continues its course, accompanied by the internal saphenous vein, down to the inner side of the foot, as far as the metatarsophalangeal joint, after crossing the ankle anterior to the internal malleolus. Beneath the sartorius muscle the internal saphenous nerve inosculates with the obturator and internal cutaneous nerves to form the obturator plexus.

The superficial branches are chiefly sensory and cutaneous in their distribution. They consist of the middle and internal cutaneous nerves. The middle cutaneous nerve divides into an external and an internal branch which supply the anterior aspect of the thigh as far as the knee. The internal cutaneous nerve divides into anterior and posterior branches. The former are distributed to the thigh and knee, while the latter takes a downward course on the anteromedial aspect of the thigh, beneath the sartorius muscle, becomes superficial on the inner side of the knee, inosculates with the obturator and internal saphenous nerves, and supplies the lower part of the inner aspect of the thigh and upper portion of the leg.

Technic.—With the patient lying in the supine position, the femoral artery is defined by palpation, immediately below Poupart's ligament, and a wheal raised about 1 cm. lateral to the artery. With a finger held on the artery, needle No. 2 (5 cm.), unattached to the syringe, is inserted through the wheal and advanced in a direction perpendicular to the surface of the skin, until the resistance offered by the fascia iliaca is overcome. The needle is then gently and gradually advanced about 1 cm. deeper, and, as soon as paresthesias are obtained, the syringe is connected with the needle and 5 c.c. of the 2 per cent. solution are injected without moving. If the point of the needle does not reach the nerve by the first puncture, the needle is partly withdrawn and its direction slightly changed outward, then inward, care being exercised to keep the finger on the femoral artery, retracting it inward, if necessary, so as to protect it from the point of the needle. Ordi-

narily, paresthesias are induced after two or three trials, radiating toward the knee or the inner side of the leg and foot. In the absence of radiating sensations the solution is distributed fanwise beneath the fascia iliaca, in the substance of the muscle; but the resulting anesthesia is not as reliable as when paresthesias are induced.

Indications. The anterior crural block is indicated for operations on the anterior portion of the thigh, but its chief indication is the anesthesia of the lower extremities, for which it is associated with the blocking of the external cutaneous, obturator, and sciatic nerves.

OBTURATOR BLOCK

(Blocking of the Obturator Nerve)

The obturator nerve leaves the pelvis through the obturator canal, where it divides into its terminal branches, the anterior and the posterior, after supplying the obturator externus muscle. The anterior branch gives off articular branches to the hip-joint, muscular branches to two of the adductors and the gracilis muscle, and cutaneous branches which are distributed to the integument of the lower inner portion of the thigh. It inosculates with the internal cutaneous and obturator nerves to form the obturator plexus. The posterior branch is mainly muscular (obturator externus, adductores magnus and brevis) and articular (hip- and knee-joints).

Technic.—With the patient lying in the recumbent dorsal position and the thigh on the side to be injected placed in abduction, the pubic spine on that side is defined and a wheal raised just below and lateral to it. Needle No. 3 (8 cm.), unattached to the syringe, is introduced through the wheal in a direction perpendicular to the surface of the skin and advanced toward the horizontal ramus of the pubis. As soon as the needle impinges on the bone it is partially withdrawn, so as to change its direction, its shaft inclined a little inward and downward (80 degrees), and reintroduced until its point comes again in contact with the bone. The upper wall of the obturator canal is then felt and the needle passed beneath it and advanced 2 cm. further in the canal, keeping close contact with that wall and following its general direction

outward, backward, and upward (Fig. 192). Injection is then made of 10 c.c. of the 1 per cent. solution, while the needle is slightly moved to and fro, thus distributing the solution on a certain length of the canal. Paresthesias are exceptionally induced during these manipulations, the anesthesia being secured by the diffusion of the solution in the connective tissue in which the nerve is embedded.

Fig. 192.—Obturator block.

Indications.—The obturator block finds an indication for certain types of femoral herniotomies. Associated with the blocking of the anterior crural, external cutaneous and sciatic nerves it is indicated for operations on the lower extremities.

Paraventebral Sacral Block

(Blocking of the Sacral Nerves)

The sacral nerves can be injected one by one, like the dorsal or the lumbar nerves, by passing the needle through the posterior sacral foramina, which represent the spaces between the fused transverse processes of the sacral vertebræ. This procedure constitutes "transsacral block" (transsacral route of Danis). They can also be reached at their exit from the anterior sacral foramina by distributing the anesthetic solution on the anterior aspect of the sacrum, which procedure is termed "presacral block" (parasacral conduction anesthesia of Braun).

The sacral nerves can be anesthetized by a third procedure which consists in passing the needle through the sacral hiatus and depositing the solution within the sacral canal. Strictly speaking, this does not constitute a paravertebral block, since the injection is not made without the spine. It will be described, however, at the end of this chapter because it relates to the sacral nerves. It is known as "extradural, epidural, or caudal block" (Cathelin, Läwen).

Sacrum.—Originally composed of separate segments, the sacrum is, in the adult, blended into one bone. It is composed of five fused and modified vertebræ which decrease considerably in size from above downward and are curved frontward. The sacrum is a wedge-shaped bone enclaved between the iliac bones, with which it is connected by joints and ligaments. Its upper surface or base supports the rest of the vertebral column, from which it is separated by the last lumbar disk; its apex gives attachment to the coccyx (Fig. 193).

The *posterior surface* of the sacrum is very irregular owing to the modifications of the fused laminæ of the sacral vertebræ. It is convex, especially in the frontal plane, and its convexity faces upward and backward, when the bone is considered in its natural position in the human body. It offers, on each side of the fused spinous processes, two rows of openings, called *posterior sacral foramina*, through which the posterior divisions of the sacral nerves find their way to the soft tissues of the sacral region at the back. These rows of foramina are almost parallel with the midline, although inclined a little downward

and inward, following the general direction of the margins of the bone. There are four sacral foramina, very seldom five, the fifth nerve emerging just above the sacral cornu and passing outward and downward in its immediate vicinity. When there is a fifth foramen, it lies immediately above the sacral cornu. The fusion of the laminæ on the

Fig. 193.—The sacrum in relation to the neighboring bony structures.

midline gives rise to a row of ill-defined spinous processes, called *spinous crest*, extending from the first to the fourth spinous process, both of which are present in the majority of cases. The fifth sacral spinous process is absent owing to the non-closure of the spine at that level, leaving at the lower extremity of the bone an opening called *sacral hiatus*, which

has the shape of an inverted U or V. The fourth spinous process is occasionally missing and the sacral hiatus, therefore, increased in height, owing to the displacement of its vertex to a higher level. The arms of the inverted U or V are, as a rule, thick and prominent, and their extremities form salient tubercles, easily defined by palpation (Fig. 193); but sometimes they are smooth and thin, without any marked differentiation from the rest of the bone, and palpation only reveals

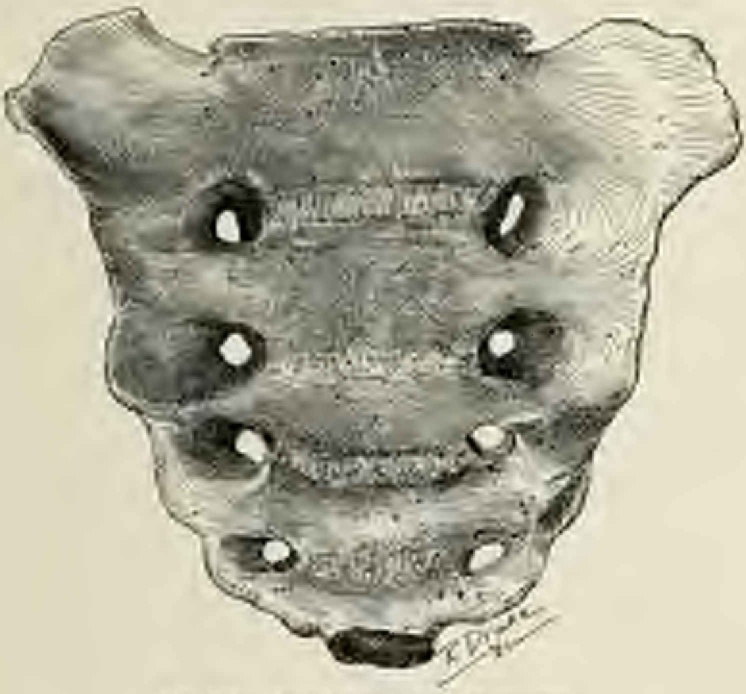

Fig. 194.—Anterior aspect of the sacrum.

the presence of a depression at the site of the hiatus, bounded on each side by an ill-defined bony edge which represents the sacral cornu.

The posterior sacral foramina are generally oval, with a greater transverse diameter of about 1 cm. The first sacral foramen is partly blinded by a triangular bony lamella, sprung from the posterior aspect of the bone and having its base attached to the medial margin of the foramen, thus rendering its penetration by the needle somewhat difficult. Its distance from the midline is about 2 cm., while that of the fourth sacral foramen is about 1.5 cm. The straight line passing

through the first and fourth sacral foramina passes also through the other foramina and is slightly inclined inward and downward. The second sacral foramen is 1 cm. medial to and below the posterior superior iliac spine.

The *anterior surface* of the sacrum is smooth as compared with its posterior aspect (Fig. 194). It is formed by the union of the bodies and lateral masses of the five sacral vertebræ. It is triangular and concave. It has two rows of foramina, the anterior sacral foramina, which are homologous to the posterior sacral foramina and give passage to the anterior divisions of the sacral nerves. Each anterior sacral foramen faces its homologous posterior foramen, both lying at the extremity of a canal whose length varies with the thickness of the sacrum at the level considered (Fig. 202). At the first sacral foramen the canal is 2.5 cm. long; at the second, 2 cm.; at the third, 1.5 cm.; and at the fourth, from 0.5 to 0.7 cm. It is of paramount importance to have these figures in mind while blocking the sacral nerves by the transsacral method, as will be seen later on.

Sacral Plexus.—The sacral plexus is formed by the union of the first three sacral nerves and the lumbosacral cord (fourth and fifth lumbar nerves), and receives as a contribution the ascending division of the fourth sacral nerve. The resulting composite structure forms a broad triangle (Fig. 195), whose base coincides with the row of anterior sacral foramina and extends upward to the fourth lumbar vertebra, and whose vertex lies at the great sciatic foramen. The sacral plexus is situated on the anterior surface of the sacrum, from which it is separated by the pyriformis muscle, and is covered by the parietal portion of the pelvic fascia. In front of it lie the ureter, the pelvic colon and part of the rectum, the iliac artery and vein. The iliolumbar, superior gluteal, and sciatic vessels also bear a close relation to the plexus. The sacral plexus gives off two sets of branches, viz., collateral and terminal.

The *collateral branches* are divided into anterior and posterior. The *anterior collateral branches* contribute to the pudendal plexus and include muscular and articular branches, supplying the quadratus femoris, the obturator internus, the gemelli, the hamstrings and the adductor magnus, and the posterior portion of the capsular ligament of the hip-

joint. The *posterior collateral branches* supply the pyriformis and the glutei muscles, the tensor fasciæ femoris, and the short head of the biceps.

The *terminal branch* of the sacral plexus is the great sciatic nerve.

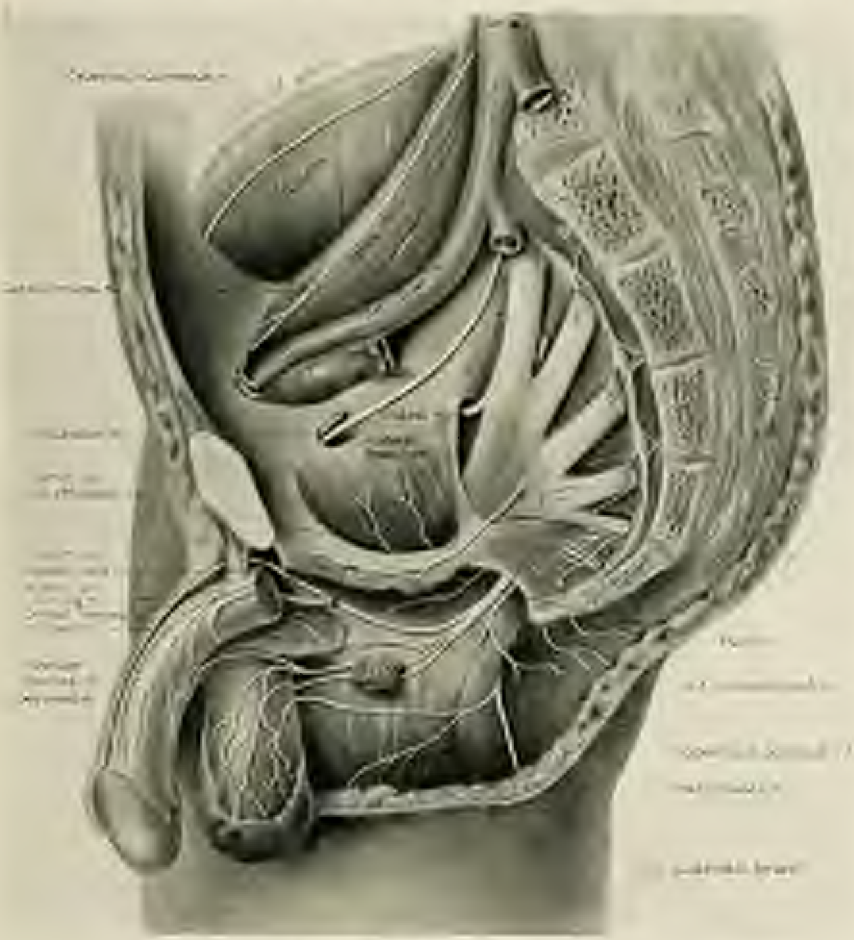

Fig. 195.—Sacral plexus.

Pudendal Plexus.—The pudendal plexus is formed by the union of the anterior collateral branches of the sacral plexus (first, second, and third sacral nerves), the fourth and fifth sacral nerves and the coccygeal nerve, to which are added contributions from the sympathetic system. The pudendal plexus is situated on the posterior wall of the pelvis and

is more the continuation of the sacral plexus than a distinct structure. It divides into visceral and muscular branches and gives rise to the small sciatic nerve, the pudic nerve, and the sacrococcygeal plexus.

(a) The *visceral branches* are derived chiefly from S^2, S^3, and S^4. They unite with fibers borrowed from the hypogastric plexus and from the sacral portion of the sympathetic chain to form the pelvic plexus, an elaborate network containing numerous small ganglia, from which are given off the hemorrhoidal, vesical, prostatic, cavernous, and utero-vaginal plexuses.

(b) The *muscular branches* supply the levator ani, the coccygeus, and the external sphincter ani, and distribute sensory fibers to the integument covering the base of the ischiorectal fossa and the tip of the coccyx.

(c) *Small Sciatic Nerve.*—The small sciatic nerve is purely sensory. It arises from the back of the plexus, from the second and third sacral nerves, and occasionally receives a contribution from the first sacral nerve. It leaves the pelvis through the great sacrosciatic foramen, below the pyriformis muscle, and descends in the gluteal region between the tuberosity of the ischium and the great trochanter, posterior to the great sciatic nerve (Fig. 215), emerging into the thigh at the lower border of the gluteus maximus muscle. It runs downward beneath the fascia femoralis, and, on reaching the popliteal space, becomes superficial. Continuing its course downward in the superficial fascia, it inosculates with the external saphenous nerve and extends to the upper half or two-thirds of the leg, dividing into tiny filaments which are distributed to the skin of that region. The small sciatic nerve gives off sensory fibers to the posterior surface of the thigh and leg, from its emergence beneath the gluteus maximus muscle all the way down. It gives off four branches, viz., the inferior pudendal, the gluteal, the femoral, and the sural. The *inferior pudendal nerve* is the only branch that needs the special attention of the anesthetist because of its distribution to the integument of the scrotum and base of the penis, or that of the labium majus and clitoris. It must be remembered that the inferior pudendal nerve leaves the small sciatic nerve at the lower margin of the gluteus maximus muscle, curves below the tuberosity

of the ischium, then passes in the fold between the thigh and the perineum, and enters the perineum after piercing the deep fascia lateral to the ischiopubic ramus, where it sends off its terminal branches to the posterior surface of the scrotum and base of the penis, or to the homologous regions of the labium majus and clitoris. The inferior pudendal nerve contributes with the ilio-inguinal and pudic nerves to form the scrotal plexus (Figs. 195 and 196).

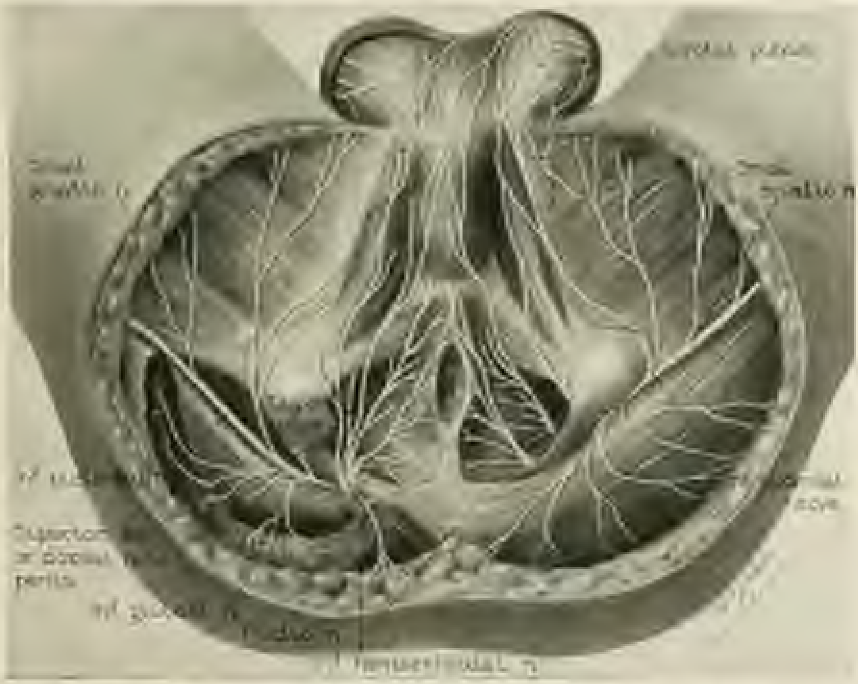

Fig. 196.—Male perineum, showing distribution of the pudic nerve and the pudendal branch of the small sciatic.

(*d*) *Pudic Nerve.*—The pudic nerve originates, like the visceral branches of the pudendal plexus, from S^2, S^3, and S^4. It leaves the pelvis through the great sacrosciatic foramen, passes over the spine of the ischium and enters the ischiorectal fossa through the small sacrosciatic foramen. It gives off the inferior hemorrhoidal nerve and runs forward in the obturator fascia along the ischiopubic ramus of the innominate bone, and, on approaching the base of the triangular ligament, divides into its terminal branches, the perineal nerve and the dorsal

nerve of the penis or clitoris, which communicate with the inferior pudendal nerve, branch of the small sciatic nerve. The pudic nerve supplies the external anal sphincter and the integument of the anal region, the perineum and upper inner aspect of the thigh, the integument of the scrotum or labium majus, the muscles of the perineum, the urethra, and the penis in its anterior two-thirds (Figs. 196 and 197).

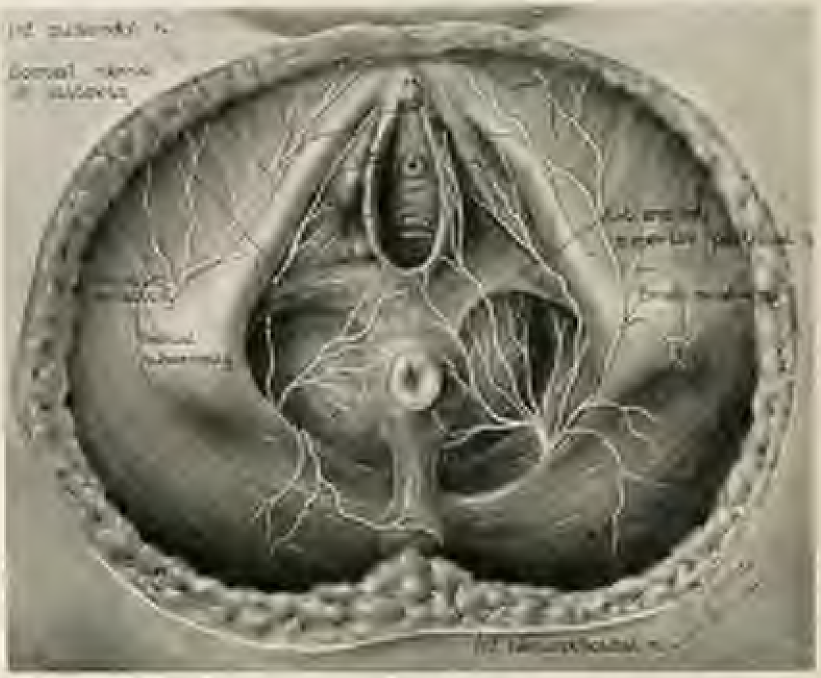

Fig. 197.—Female perineum, showing distribution of the pudic nerve and the pudendal branch of the small sciatic.

Sacrococcygeal Plexus.—The sacrococcygeal plexus is derived from the fifth sacral and the coccygeal nerve, with a contribution from the fourth sacral nerve. Its branches, which are tiny filaments, are distributed to the integument of the coccygeal region, occasionally to the coccygeus and gluteus maximus muscles.

Great Sciatic Nerve.—The great sciatic nerve, the largest trunk in the body, leaves the pelvis through the great sacrosciatic foramen below the pyriformis muscle, turns downward between the great trochanter and the tuberosity of the ischium (Fig. 215), and enters the

thigh beneath the lower margin of the gluteus maximus muscle (page 286).

The foregoing description of the sacrum and sacral plexus, conceived and worded from an essentially practical point of view, brings out the following salient features:

1. For the purposes of regional anesthesia the sacrum must be studied as part of the bony structure of the pelvis much more than as an individual bone.

2. The only landmarks are the sacral cornu and the posterior superior iliac spine on the same side.

3. The posterior sacral foramina lie along two straight lines, one on each side of the sacrum and almost parallel with the midline of the back, although slightly inclined inward and downward. Each of these lines passes through the sacral cornu and a point 1 cm. medial to the posterior superior iliac spine on the same side.

4. The second sacral foramen is 1 cm. medial to and below the posterior superior iliac spine; the fifth foramen, just above the sacral cornu.

5. Each posterior sacral foramen is the extremity of a canal bored at right angles to the surface of the bone, whose length varies with the thickness of the sacrum, decreasing therefore from top to bottom. The other extremity of the canal is the anterior sacral foramen which opens into the pelvis.

6. The anterior sacral foramina are consequently on two straight lines following the same direction as those of the posterior foramina.

7. The convexity of the posterior surface of the sacrum is turned upward and backward. The upper portion of the sacrum is, therefore, deeply situated.

8. The sacral plexus is a broad triangle lying on the anterior surface of the sacrum, from which it is separated by the pyriformis muscle.

9. The collateral branches of the plexus are destined chiefly for the pelvis and pelvic organs, except the small sciatic, which distributes most of its filaments to the integument of the posterior aspect of the thigh and upper half or two-thirds of the leg.

10. The pudendal plexus originates from all the sacral nerves and is joined by the coccygeal nerve. It contributes to the sensory innerva-

tion of the pelvic organs by way of the pelvic plexus, which itself receives contributions from the hypogastric plexus and from the sacral portion of the sympathetic chain.

11. The perineum is supplied by the pudic nerve, with a small contribution from the inferior pudendal nerve, branch of the small sciatic nerve.

12. The external genitalia are supplied partly by the lumbar plexus (ilio-inguinal and genitocrural nerves) and partly by the sacral plexus (pudic and inferior pudendal nerves).

TRANSSACRAL BLOCK

Technic.—With the patient lying flat on his stomach and a cushion slipped under his hips, to raise the sacral region and render the landmarks more accessible, the posterior superior iliac spine and the sacral cornu are defined on both sides by palpation. A wheal is raised about 1 cm. medial to and below the said iliac spine and another wheal is placed just above the sacral cornu on the same side (Fig. 198). The distance between them is divided into three equal parts by two other intermediate wheals. The second, third, fourth, and fifth sacral foramina are thus easily and accurately defined. The first sacral foramen is found by raising a wheal about 2.5 cm. above that which marks the second sacral foramen, following the same general direction. The thickness of the soft tissues overlying the sacrum being much greater in the upper portion of the bone, needles of different lengths are used according to the height of the puncture. Needle No. 2 (5 cm.) is used for the three last foramina, needle No. 3 (8 cm.) for injecting into the second sacral foramen, and needle No. 4 (10 cm.) for the first foramen, which is very deeply situated. It is customary to begin with the second foramen, which seems to be easier to locate than the first, and which helps considerably in locating the others. The needle is introduced in a direction perpendicular to the surface of the skin and gently advanced toward the posterior aspect of the sacrum until its point touches the bone in the immediate neighborhood of the foramen. After losing contact with the posterior aspect of the sacrum the needle passes through the sacral foramen and, according to the foramen, is intro-

duced more or less deeply, because of the uneven thickness of the sacrum. The needle is thus advanced 2 cm. within the first, 1.5 cm. within the second, 1 cm. within the third, and only 0.5 cm. within the fourth. The fifth nerve is injected just above the sacral cornu. For the same

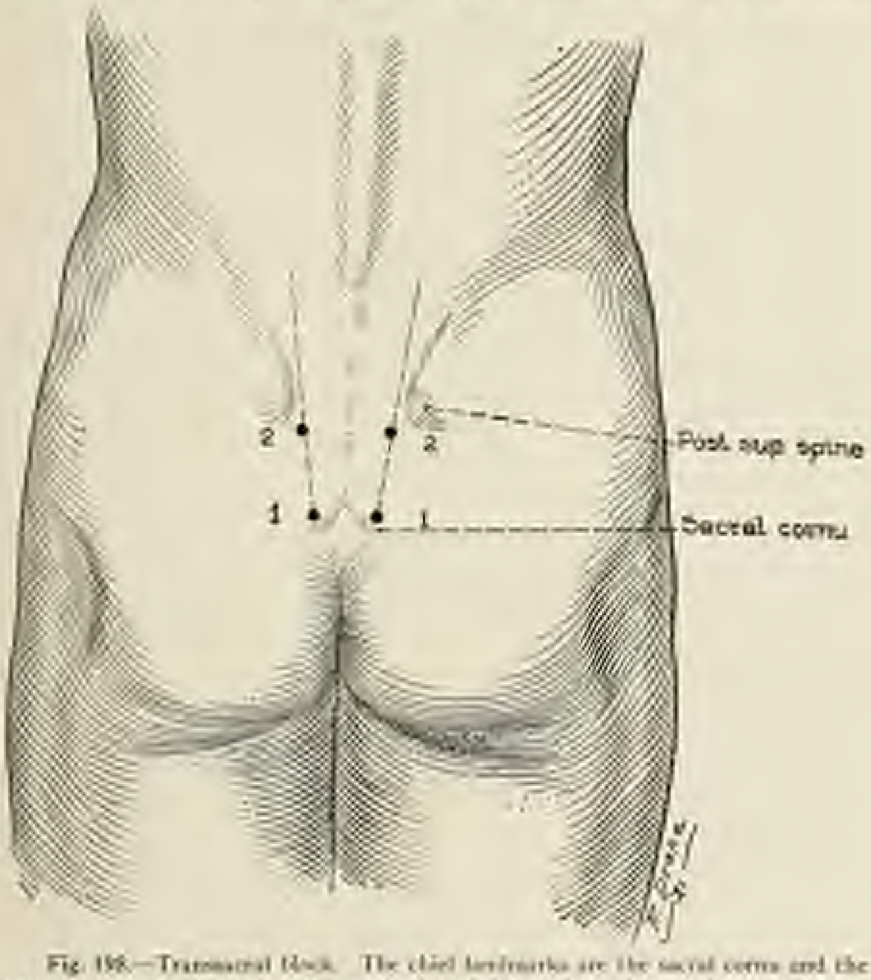

Fig. 198.—Transsacral block. The chief landmarks are the sacral cornua and the posterior superior iliac spine: 1 is a wheal raised just above the sacral cornu; 2 is another wheal placed about 1 cm. medial to and below the said iliac spine. The straight line passing through 1 and 2 marks the direction of the sacral foramina.

reason the quantity of solution injected varies with the foramen. It is customary to inject 6 c.c. of the 1 per cent. solution in the first foramen and to reduce by 1 c.c. each time the quantity deposited into each subsequent foramen. Starting from the second foramen, injection is,

therefore, made of 5, 4, 3, and 2 c.c. respectively, in descending order of foramen, thus injecting a total of 40 c.c. of the 1 per cent. solution. The needle is always introduced unattached to the syringe and the aspiration test made and renewed before injecting. Immediately after the last injection the sensibility of the anus and perineum is tested by

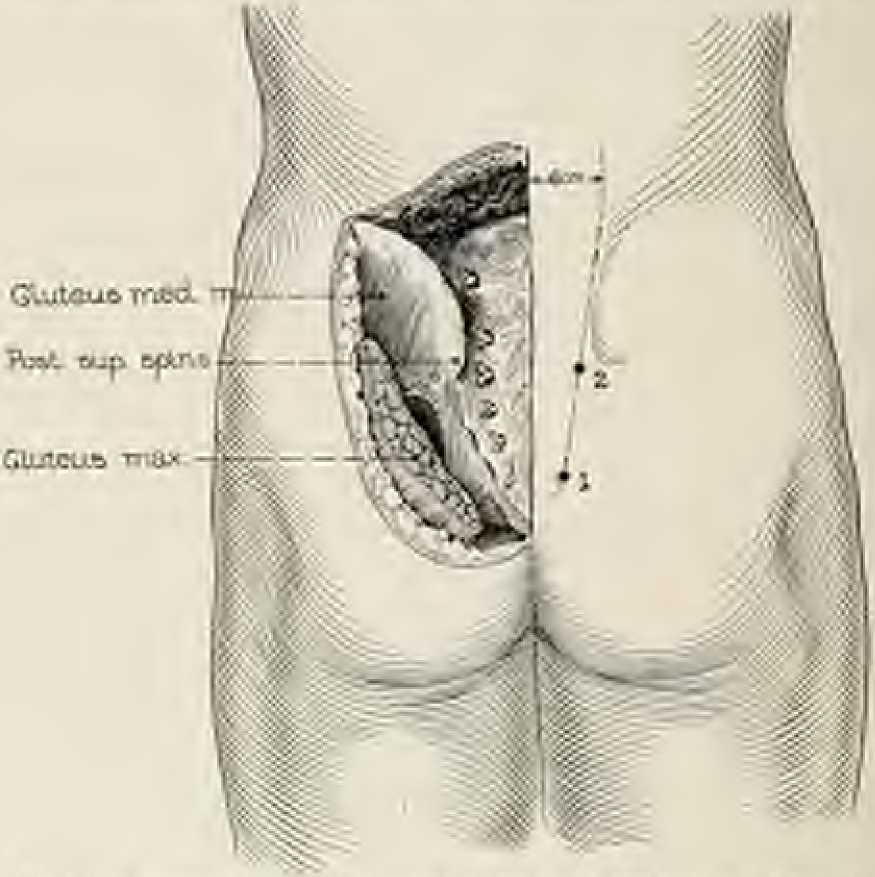

Fig. 199.—Transsacral block. The superficial landmarks in relation to the posterior sacral foramina.

clamping these regions. The anesthesia sets in very rapidly and, in the majority of cases, the operation can be begun soon after the injections have been completed. The relaxation of the anal sphincter is the characteristic proof of absolute anesthesia. The anesthesia following the transsacral block is one of very long duration, covering a period of

from three to four hours in the majority of cases, especially when associated with the caudal block.

Indications.—Transsacral block is indicated for all operations on the perineum, anus, rectum, vagina and cervix, prostate, and bladder. For suprapubic prostatectomy it is necessary to infiltrate the abdominal wall (page 406). For the posterior resection of the rectum and rectosigmoid it is associated with the paravertebral lumbar block of the last three lumbar nerves, which gives a more complete anesthesia of the parietal peritoneum and the pelvic organs in women (page 414). This last procedure is also good for vaginal hysterectomy. In case of abdominal hysterectomy the abdominal field block must be induced according to the technic described on page 417. Although exceptionally employed for operations on the lower extremities, the transsacral block may be associated with the blocking of the lumbar nerves from L^2 to L^3 for amputation of the thigh or resection of the knee, if spinal anesthesia cannot be induced or does not appeal to the surgeon as an absolutely safe procedure in a particular case. The injections are then made on one side only. The transsacral block finds also an indication in the treatment of severe forms of sciatica; in such cases it is associated with the caudal block.

Practical Considerations.—*Landmarks.*—The *posterior superior iliac spine* is defined with great accuracy by palpating the iliac crest. Starting from a higher level, the tips of the fingers gradually feel the sharp edge of the posterior portion of the ilium lying obliquely inward and downward, and finally lose contact with the bone. The extremity of that edge is the posterior superior iliac spine. In very lean patients the prominences of the framework can be recognized by sight; but they gradually become less salient with the increasing weight of the patient and finally disappear in fat people, in whom accuracy in defining landmarks greatly depends, as a rule, on the experience of the operator. When raising the wheal 1 cm. medial to and below the posterior superior iliac spine the correct margin should be allowed for the thickness of the soft structures overlying the bone.

The *sacral cornu* is defined with the sacral hiatus. The sacral hiatus is found by passing the tip of the index-finger along the midline of the

region, starting from the tip of the coccyx in the gluteal cleft, coursing upward toward the sacrum. A depression is felt at about the juncture of the coccyx with the sacrum, and bounded by the sacral cornua on each side and the fourth sacral spinous process on the midline a little

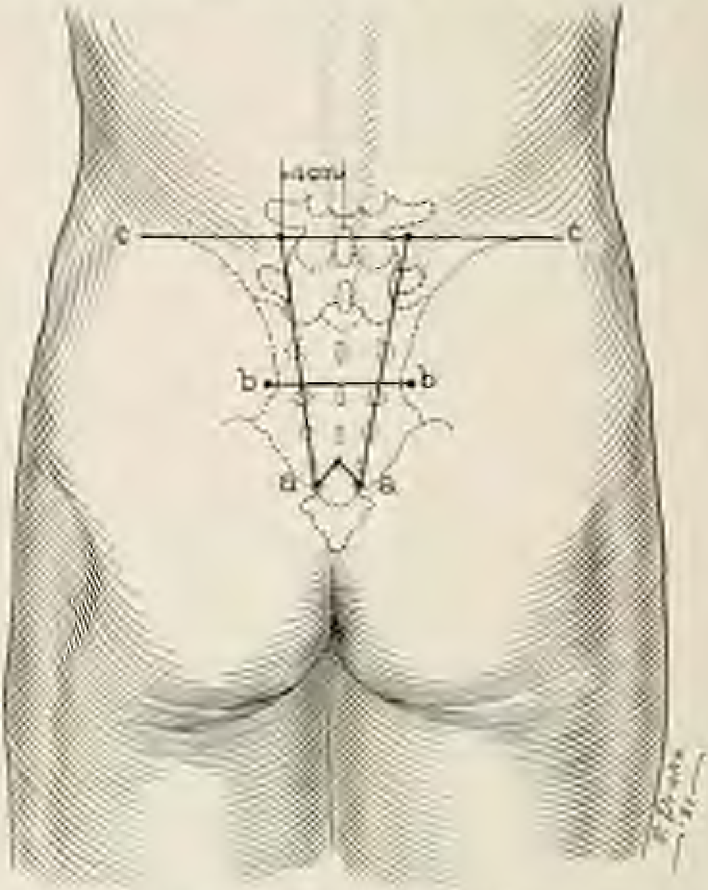

Fig. 200.—Transsacral block. Tracing of the lateral rows of sacral foramina on the skin surface: a, a, are the sacral cornua; b, b, the posterior superior iliac spine; c, c, the line tangent to the highest points of the iliac crests.

higher up. These three prominences, easily palpable in the majority of cases, are defined with great accuracy in lean patients. In the very fat it is necessary to palpate with some pressure so as to locate the depression of the hiatus, which lies generally slightly higher than the extremity of the gluteal cleft (page 280).

The lateral rows of posterior sacral foramina may be traced on the skin in the following manner: A straight line is drawn across the back through the uppermost points of the iliac crests. On this line, which passes through the fourth lumbar spine or between the fourth and fifth, two points are taken, one on each side, 4 cm. distant from the midline of the back, and these points are joined to the sacral cornua (Fig. 200). On the two oblique lines thus traced wheals are raised: the first, medial to the posterior superior iliac spine, marks the point of entrance to the second foramen; the second, just above the sacral cornu, is the site of injection of the fifth sacral nerve. Two intermediate wheals divide the distance between the first two into three equal parts and serve for the injection into the third and fourth foramina. The first foramen is 2.5 cm. above the second. This manner of taking the superficial landmarks, which is a variation of the one described on page 260, is of great value in those exceptionally fat patients whose prominences of the framework are so deeply situated that they offer to the tactile sense stimulations wanting in precision. The distances between two consecutive foramina, starting from the first, are: 2.5, 2, 1.5, and 1.5 cm. respectively. It is thus possible to start either from the sacral cornu or from the posterior superior iliac spine, according as it has been possible to define one of these landmarks with sufficient accuracy.

The patient must not change position during these manipulations; nor should he be allowed to do so after the superficial landmarks have been taken, in any case.

Puncture.—As a rule, the needle is introduced through the wheal and advanced toward the posterior aspect of the sacrum in a direction perpendicular to the surface of the skin. But, owing to the curvature of the bone and to the deep situation of its upper portion, the needle should be inclined slightly downward for the puncture of at least the first two foramina, especially in fat patients. The first foramen is sometimes so deeply situated that from 6 to 7 cm. of the shaft of the needle disappear before its point touches the bone. The needle, in this case, approaches the posterior surface of the sacrum obliquely when it is introduced in a direction perpendicular to the surface of the

skin; so that, if the foramen is sought for in an upward direction, the needle glides along the bone, thus giving the impression that it is being advanced within the foramen. The punctures are all made in the same plane, viz., that which passes through the row of sacral foramina perpendicularly to the surface of the skin, and the foramina sought for preferably inward of that plane, but never outward, since the needle

Fig. 201.—Transsacral block. Note the direction of the posterior surface of the sacrum in relation to the surface of the skin at the sites of puncture, the depth of the foramina beneath the skin and the direction of the needle for the puncture of each foramen.

is liable to enter the sacro-iliac articulation or pass laterally to the sacrum, according to the height of puncture. A little practice ordinarily gives an almost accurate tactile sense of the rich fibrous structures overlying the foramen and spreading out, so to speak, in its immediate neighborhood. The direction of the needle is slightly changed if the foramen is not reached by a first puncture; but gentleness must be used in approaching the bone, so as not to hurt the patient, trauma-

tize the region by repeated punctures, and damage the point of the needle, which bends to a hook and tears through the tissues while it is withdrawn. This faulty technic of most beginners can be improved rapidly by a short training on the cadaver.

It frequently happens that by a first puncture the needle passes directly into the sacral foramen, and unless it is stopped in due time

Fig. 202.—Transsacral block. Section of the sacrum passing through the sacral foramina on the right side, showing the thickness of the bone at each foramen: 2.5 cm. at s^1, 2 cm. at s^2, 1.5 cm. at s^3, and from 0.5 to 0.3 cm. at s^4.

enters the pelvis or hits the nerve on its way through the foramen. If the nerve is touched while the needle is gently advanced in the depth the solution is deposited without moving, after making sure that the territory of the radiating sensations is actually that supplied by the nerve. If no paresthesias are induced at a depth which varies with the patient and with the foramen the needle is partially withdrawn and reintroduced in a slightly modified direction with a view to seeking

contact with the posterior aspect of the sacrum. The knowledge thus acquired of the depth of the sacrum beneath the surface of the skin leads to accurate knowledge of the depth to which the needle is subsequently advanced into the sacral foramen. Contacts are, therefore, sought with points north, south, east, and west of the foramen supposed to have been reached by the first puncture, each time withdrawing the needle so as to change its direction. If the bone is felt at the "cardinal points of the foramen" more superficially than the depth first attained by the point of the needle, the inference is that the needle had actually passed into the foramen by the first puncture. But if no bone is felt *laterally*, the needle in all probability is being advanced on the outer margin of the sacrum or in the sacro-iliac joint, according to the height of the puncture. Fanwise punctures between the equatorial points of the foramen will then correct any possible error and restore the needle to its original position. With a little experience it is easy to know when the point of the needle pierces the fibrous layer stretched over the foramen. Beginners are advised to keep the needle in the foramen after making the first injection into the second foramen, especially if some difficulty was experienced in locating that foramen, or if it was not possible to define the superficial landmarks with sufficient accuracy. The position of the needle thus left in the foramen facilitates the puncture of the homologous foramen on the opposite side and renders it easier to locate the other foramina.

Postoperative Care.—Following the transsacral block the patient should not be allowed to assume the recumbent dorsal position in bed unless the sacral region has been protected by a round air-cushion, so as to prevent local disturbances due to pressure on those tissues whose vitality has been temporarily reduced by the anesthetic solution. The occasional retention of urine following transsacral block is of very short duration and yields after a few catheterizations. Incontinence of urine may also happen and is treated by the use of a permanent catheter retained for one or two days. Prolonged incontinence or retention are exceptional. They occur in women especially after the posterior resection of the rectum or a vaginal hysterectomy, and it is hard to hold the method responsible for such conditions, since they may exist

after similar operations performed under general narcosis. Is it not more plausible to incriminate the partial destruction of the innervation of the vesical sphincter in the course of such operations? Massage of the sphincter through the vagina is in such cases indicated; but time should be allowed for a collateral nerve supply or a new education of the sphincter to the poor innervation left.

PRESACRAL BLOCK

With the patient lying in the dorsosacral or lithotomy position, the sacrococcygeal joint is defined by passing the tip of the index-

Fig. 203.—Presacral block. The left forefinger marks the right side of the sacrococcygeal joint, while the needle is inserted through a wheal raised on the left side of the joint at a distance of 2 cm. from the midline. Note the direction of the needle aiming at the table so as to reach the edge of the sacrum.

finger along the lateral margin of the coccyx, starting from the tip of that bone, until it is stopped by the great sacrosciatic ligament (Fig. 203). Two wheals are raised, one on each side of the joint, from 1.5 to 2 cm. distant from the midline. Needle No. 4 (10 cm.) is introduced through one of the wheals and advanced toward the anterior surface of the sacrum in a direction parallel with the sagittal plane of the body.

After taking contact with the edge of the sacrum the needle feels its way past that edge along the anterior surface of the bone until it is stopped at a depth of from 6 to 7 cm. from its point of entrance, no account being taken of the soft structures overlying the first point of contact. The point at which the needle is stopped is a little above

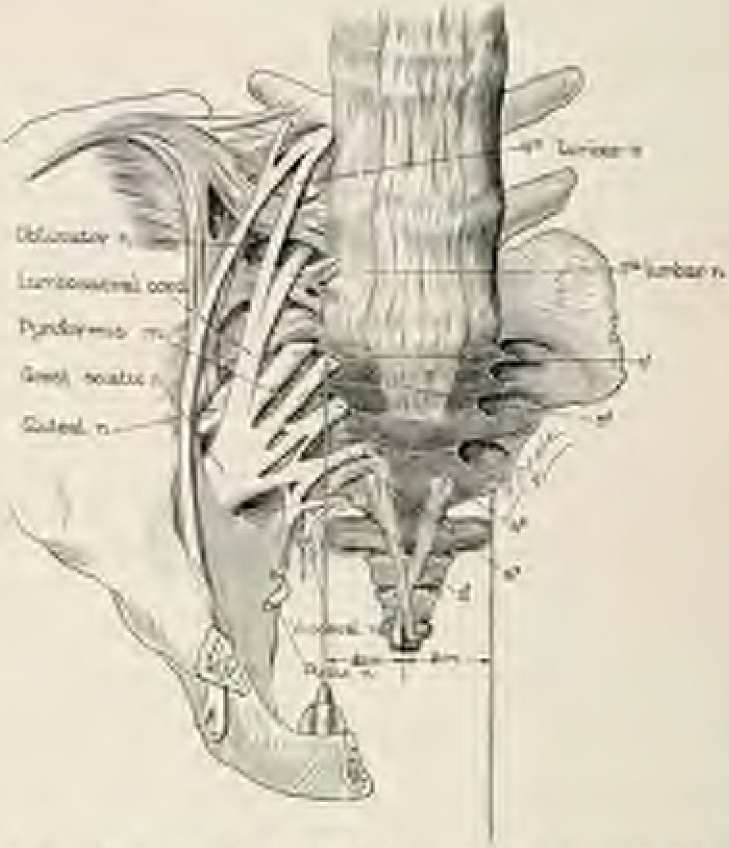

Fig. 204.—Presacral block. On the left side the needle takes contact with the edge of the sacrum before it is advanced on the anterior aspect of the bone. On the right the needle has reached s^2. Note its direction, which is always parallel with the midline.

the second sacral foramen (Fig. 204). The entire distance from the second to the fifth foramen is injected with 20 c.c. of the 1 per cent. solution. No injection should be made until contact with the bone is felt. The needle is then withdrawn and needle No. 5 (12 cm.) introduced through the same wheal and advanced toward the edge of the

sacrum, as for the first injection. After impinging on that edge, the needle is directed at a small angle toward the innominate line, always keeping it in a plane parallel with the sagittal plane of the body. The needle penetrates deeper than before and reaches the bone a little above the first sacral foramen, at a distance of about 10 cm. from its point

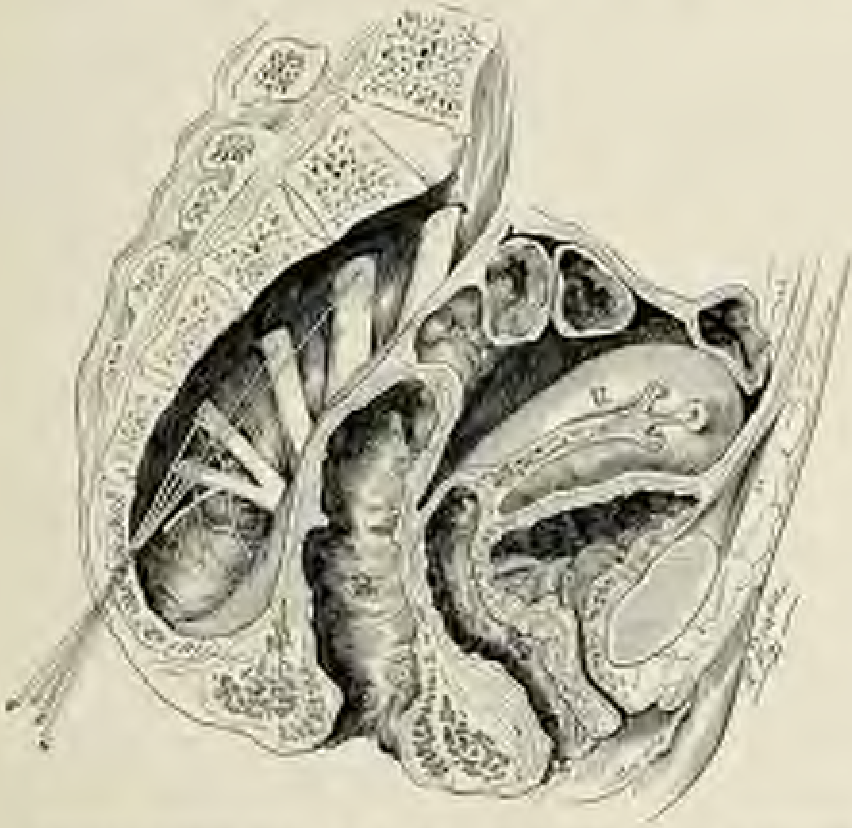

Fig. 205.—Presacral block. Sagittal section of the pelvis showing the directions of the needle. The pelvic organs have been retracted frontward for the purposes of illustration.

of entrance. At this point 20 c.c. of the same solution are injected close to the bone. The needle is then drawn back and passed between the rectum and the coccyx, where a last injection is made of 5 c.c. of the same solution. The injections are repeated on the opposite side, using a total of about 100 c.c. of the 1 per cent. solution.

If the operator feels that he should control the position of the needle, especially in making the deep injection at the level of the first sacral foramen, a finger is placed in the rectum and only removed when the anesthetic procedure has been completed, avoiding by this precaution the possible contamination of the needle. For the purpose of refilling the syringe the care of the instruments is left to an assistant. But the author agrees with Braun that it is not necessary to place a finger in the rectum as a guide for the needle, "as the empty bowel is not easily injured and evades the needle."

Practical Considerations.—The anesthesia produced by the presacral block is said to be similar to that resulting from the transsacral block, since the nerves blocked are the same, apart from the fact that the posterior primary divisions of the sacral nerves are not reached by the presacral injections. Differences, however, exist in the quality of the anesthesia and in its duration when comparing the clinical results obtained with both procedures. In the transsacral block the increased pressure on the nerves due to the retention of the anesthetic fluid in the foramen, which is a partially closed space, establishes favorable conditions for rapid anesthesia. More time is taken for the destruction locally of the solution thus injected, since its diffusion to the neighboring structures is quite limited. The anesthesia following the transsacral block is, therefore, of longer duration.

The presacral block is certainly much easier and more quickly done than the transsacral block, but it is less clean, less precise, less anatomic, and does not admit of poor technic. It must not be used as a routine procedure. It has, besides, the disadvantage of requiring the lithotomy position, which is incompatible with the paravertebral lumbar block often associated with the blocking of the sacral nerves for operations on the pelvic organs.

CAUDAL BLOCK

Caudal block is also known as "extradural or epidural block." It consists in passing the needle through the sacral hiatus and depositing the anesthetic fluid within the sacral canal. It differs from intraspinal block (spinal anesthesia) in that the solution is distributed outside the dura mater.

The *sacral hiatus*, through which the needle must be introduced before it is advanced deeply into the sacral canal, is the lower extremity of the spinal canal. It is an opening resulting from the defective or non-closure of the laminæ of the last sacral vertebra, screened by a thin layer of fibrous tissue called the sacrococcygeal membrane (postero-inferior obturator membrane of Cathelin) stretched between

Fig. 206.—Posterior aspect of the sacrum.

the sacrum and the coccyx, and bounded on each side by the sacrococcygeal ligaments. The sacral hiatus lies at about the juncture of the sacrum with the coccyx, and is bounded by the sacral cornua on each side and the spinous process of the fourth sacral vertebra on the midline a little higher up. It has the shape of an inverted V or U. The arms of the inverted V or U are generally salient edges and their

extremities prominent tubercles; but in a certain number of cases these anatomic features are thin and flat and cannot be defined by palpation, even in lean patients.

The *sacral canal* is a prismatic space occupying the whole height of the sacrum. Its upper extremity is connected with the spinal canal, of which it is the continuation. Its lower extremity is the sacral hiatus.

Fig. 207.—Side view of the sacrum.

The sacral canal follows the curvature of the sacrum, especially that of its posterior surface, and is more marked in middle age than in childhood. It has two walls, the anterior and the posterior, which follow the general direction of the anterior and posterior aspects of the bone, and are, therefore, more distant from each other in the upper portion of the canal. The anterior wall of the canal is formed by the fusion of the bodies of the vertebræ and is somewhat rough. Its spurs or transverse prominences sometimes cause a partial obliteration of the canal

at the level of the third sacral vertebra. Its posterior wall is the result of the fusion of the vertebral laminæ and is smooth and thin, as compared with its anterior wall. Part of the lower portion of the posterior wall of the canal may be absent, thus converting the sacral hiatus into a rather long triangular opening whose vertex lies at about the middle of the height of the sacrum. Laterally, the sacral canal gives exit to the sacral nerves by way of foramina, comparable to the intervertebral foramina of the higher regions of the spine. These foramina soon divide into a Y- or V-shaped canal for the passage of the anterior and posterior divisions of the sacral nerves through the anterior and pos-

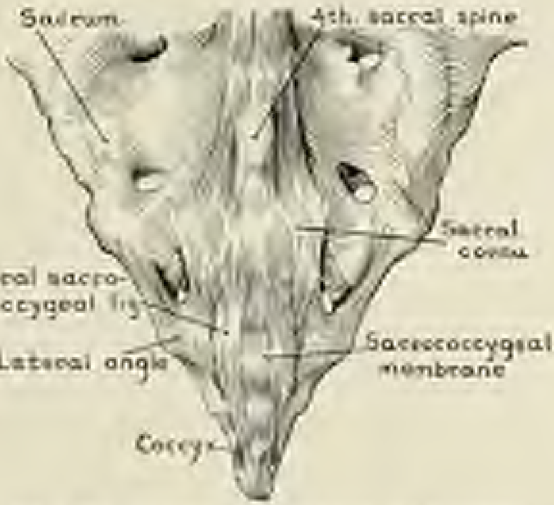

Fig. 208.—The sacrococcygeal membrane and ligaments.

terior sacral foramina. The sacral canal communicates freely with the pelvis and the ischiorectal space, owing to the absence of those fibrous ligaments which, in the other segments of the spine, wall off the spinal canal from the adjacent extraspinal structures (page 232).

The sacral canal is filled with loose, diffluent, adipose tissue, richly vascularized, and communicates freely with the epidural space of the lumbar region. In this are embedded: (1) the dural sac, continued by the filum terminale; (2) the sacral nerves and the coccygeal nerve; and (3) the sacral intraspinal venous plexuses, composed of a rich network surrounding the dural sac. The dural sac contains the lower portion

of the cauda equina and extends as far as the lower border of the second sacral vertebra in the adult, that is, from 7 to 9 cm. from the apex of

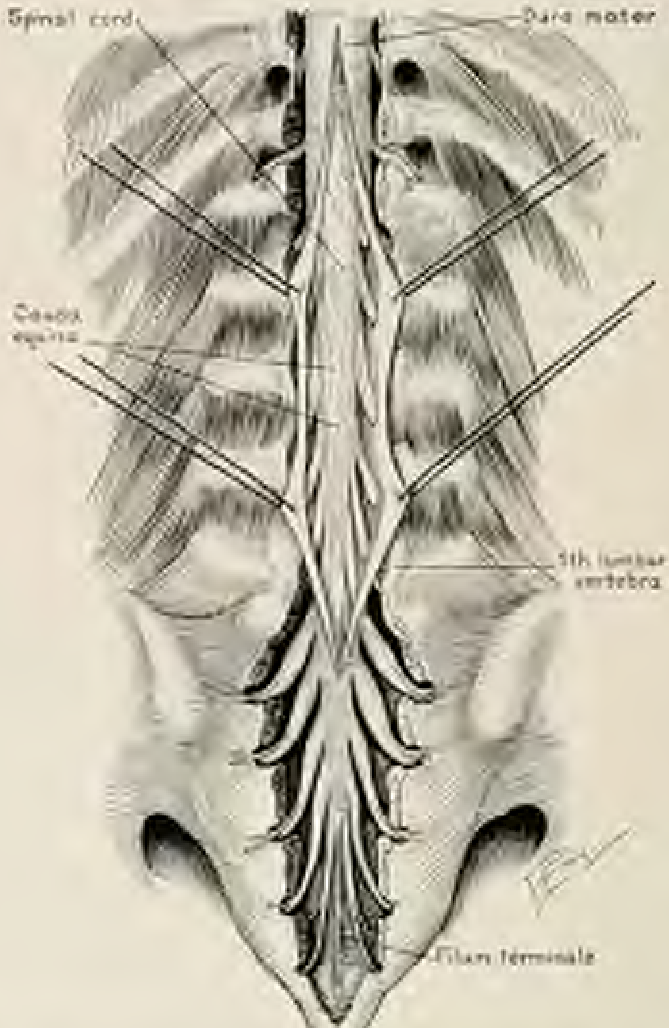

Fig. 209.—The sacral nerves as seen after resection of the posterior wall of the sacral canal.

the sacral hiatus (Cathelin). In a few cases it may extend a little further down or stop at a higher level in the lumbosacral region. The sacral nerves and the coccygeal nerve emerge from the lateral wall of

the dural sac, close to one another longitudinally, and spread out fan-wise to their respective foramina (Fig. 209), wrapped up in thick individual sheaths borrowed from the dura.

Technic.—With the patient lying flat on his stomach and a cushion slipped under his hips to raise the sacral region and render the landmarks more accessible, the sacral hiatus is defined by the left forefinger passed on the midline of the back, from the tip of the coccyx, felt in the gluteal cleft, toward the sacral region. A depression is felt at about

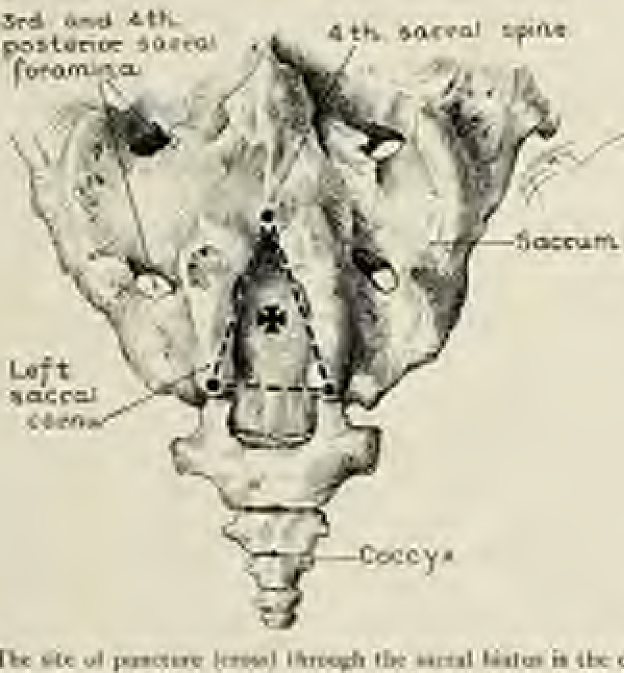

Fig. 210.—The site of puncture (cross) through the sacral hiatus in the center of the triangle formed by joining the sacral cornua and the fourth sacral spinous process.

the juncture of the coccyx with the sacrum, and bounded by the sacral cornua on each side and the fourth sacral spinous process on the midline a little higher up. These three prominences, palpable in the majority of cases, form the angles of a triangular surface at the middle point of which the needle is introduced with ease and success (Fig. 210). The spinal puncture needle, with its stylet in and its bevel turned upward, is introduced through a wheal raised at this point, in a direction making an angle of about 20 degrees with the normal to the skin

surface at the site of the puncture. After piercing the sacrococcygeal membrane which, like a screen stretched across the sacral hiatus, closes the lower extremity of the sacral canal, the point of the needle strikes the anterior wall of the canal. It is then withdrawn 1 or 2 mm. and the hub of the needle swung downward toward the gluteal cleft, increasing

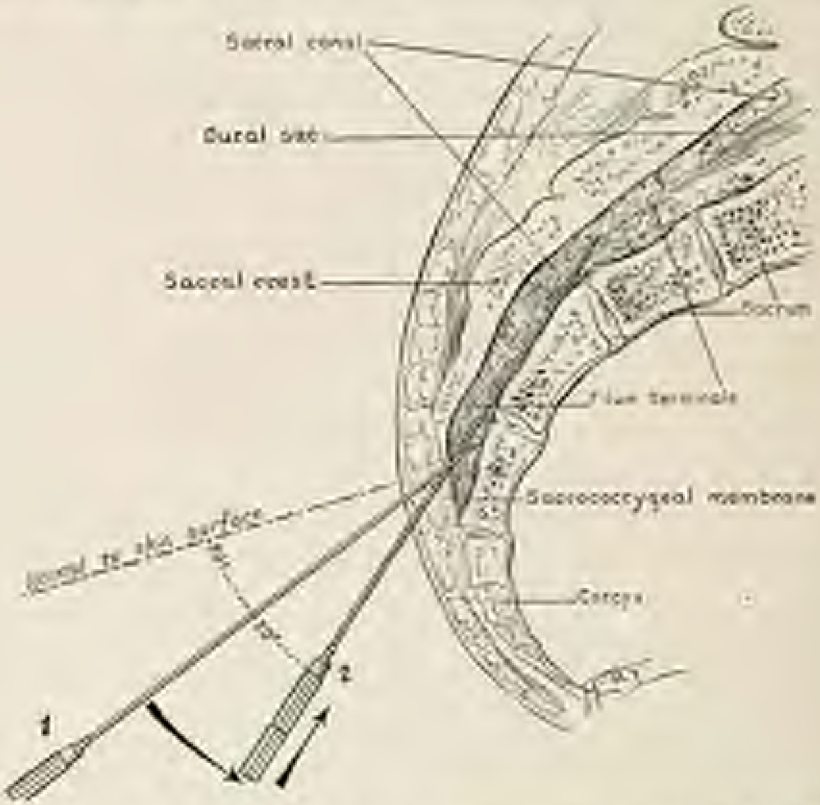

Fig. 211.—Sacral block. After piercing the sacrococcygeal membrane the needle impinges on the anterior wall of the sacral canal and passes from position 1 to position 2 in the direction of the arrows.

the angle of 20 degrees to about 40 degrees or more if necessary (page 281). The needle is advanced gently and gradually into the sacral canal, always keeping along the midline, until about 6 cm. of its length have disappeared (Fig. 211). If the point of the needle impinges on the posterior wall of the canal and is stopped at a short distance from its point of entrance, it is ordinarily released by the application of

pressure on the sacrococcygeal membrane with the left forefinger placed on the needle at the site of puncture (Fig. 212). If this device is not successful, the needle must be withdrawn and reintroduced a little higher. When the needle has been correctly introduced its stylet is withdrawn and time allowed to make sure that no blood or cerebrospinal fluid comes out. In such cases the needle is drawn back a few millimeters until the flow ceases and the syringe, filled with the 2 per cent. solution, is connected with the needle. The aspiration test is made before injecting the fluid, so as to feel quite certain that no intraspinal nor intravenous injection is actually made. The solution is then injected *very slowly*, using a total of from 30 to 40 c.c. of the 2 per cent. solution, of which the greater part is deposited without moving, and the rest distributed along the midline of the canal while the needle is withdrawn, until the syringe is completely discharged when the point of the needle reaches the sacrococcygeal membrane. The cushion is then withdrawn from under the hips of the patient, who is allowed to turn over and lie on his back. The usual test for anesthesia is made by clamping the anus. It should not be tried sooner than fifteen minutes after the injection, since the anesthesia sets in very slowly, and the operation not begun until the relaxation of the anal sphincter is apparent.

The anesthesia following the caudal block involves the anus and perineum, and extends more or less to the scrotum, penis, bladder, prostate, vulva, vagina and cervix, rectum, and ischiorectal fossa. It is of inferior quality to that obtained by the transsacral or the presacral block, owing to the low permeability of the nerve sheaths at that level.

Indications.—Caudal block is indicated for operations on the anus and lower portion of the rectum, the perineum including the posterior aspect of the external genitalia, the urethra, and at times the prostate and bladder. It is the method of choice for cystoscopy, with or without fulguration, radium therapy of the carcinomatous prostate by transperineal applications of radium needles, lithotripsy, proctoscopy, and urethrotomy. Associated with the transsacral block, it produces an almost instantaneous anesthesia of very long duration. Caudal or

epidural injections are indicated for the treatment of sciatica, coccyalgia, and other painful conditions connected with the sacral plexus.

Practical Considerations.—*Position of the Patient.*—Cathelin (1901) proposed the recumbent lateral position, with the back arched, knees brought toward the face, so as to stretch the soft tissues overlying the sacrococcygeal membrane and render its palpation and puncture easier. In this position the gluteal cleft is displaced downward by the fall of the buttock. The midpoint of the sacral hiatus lies about 1 cm. higher than the cleft. The injection being made very slowly, gravity forces the solution toward that side of the sacral canal which lies at a lower level, thus causing an uneven distribution of the anesthetic fluid, despite the rapid change to the dorsal position soon after the injection has been completed. Läwen (1910) introduced the method into surgery with marked success. He used the lateral position; but recommended the sitting erect position, because the solution is here more easily displaced by gravity toward the lower extremity of the sacral canal, which establishes very favorable conditions for the anesthesia of the anus and perineum. When the sacral block was tried for operations on regions supplied by the dorsal and lumbar segments of the cord, the genupectoral position was considered of great advantage. The horizontal ventral position is, according to the author's experience, the best of all, so long as the caudal block is not used as a substitute for the intraspinal block, but restricted to operations on the territories supplied by the sacral plexus. It has, besides, a great advantage over the genupectoral position, in that it is applicable to all kinds of patients, especially women, without hurting the modesty of some of them. The position is one of rest for weak patients.

Landmarks.—The sacral hiatus may also be defined by passing the tip of the index-finger along the midline of the back, starting from the sacrum. The prominences of the sacral crest are thus felt from top to bottom, until the fourth sacral spine is reached, below which the finger falls in a triangular depression having its base turned toward the gluteal cleft (Cathelin). This manner of defining the sacral hiatus is useful in a few cases in which it is thought advisable to control the findings arrived at with the technic described on page 263.

Puncture.—After raising the wheal at the site of puncture it is customary to pass the intradermal wheal needle deeper and inject the integument covering the sacrococcygeal membrane and the membrane itself, so as to render the subsequent puncture with the thick needle painless. The edema thus created is massaged until it has completely disappeared, thus restoring to the region its normal aspect, without which it is hardly possible to puncture at the correct spot. In practice no tracing is made of the sacral hiatus on the skin. The tip of the left forefinger is placed on the hiatus and gradually advanced toward its apex, until the edges of the laminæ or sacral cornua are felt on each side, and the needle passed beneath the tip of the finger in a direction making an angle of about 45 degrees with the surface of the skin. The needle pierces the membrane and its point strikes the anterior wall of the canal. The needle is withdrawn 1 or 2 mm. and its hub swung downward toward the gluteal cleft, reducing the angle of 45 to about 20 degrees. The needle thus lies almost horizontally or in a plane parallel to the surface of the skin of the sacral region. The tip of the forefinger is held in place at the apex of the hiatus, while the needle is advanced in the sacral canal, applying or releasing pressure on the needle at the site of puncture whenever need be, so as to prevent it from striking either wall of the canal (Fig. 212). In certain cases the bevel of the needle is turned sideways or downward during these maneuvers, according to the difficulty experienced in advancing into the canal. Sometimes the curvature of the sacral canal is such that it is necessary to curve the needle in order to introduce it deep enough. For this, among other reasons, the author has adopted the spinal puncture needle which, being made of nickel, lends itself best to such manipulations. Such a needle, being unbreakable, eliminates furthermore all risks of complicating the technic (page 40). It is possible to pass the needle on the posterior aspect of the sacrum in trying to introduce it into the sacral canal. It occurs especially in the hands of beginners who pay no heed to the tactile sense transmitted by the point of the needle at the time it pierces the sacrococcygeal membrane. It is more frequent in fat patients. A test for such false passage is the edema produced on the posterior aspect of the sacrum by the injected fluid (Fig. 213). When

the needle has been introduced in its correct place it acts like a lever whose fulcrum is at its point of entrance through the membrane; the

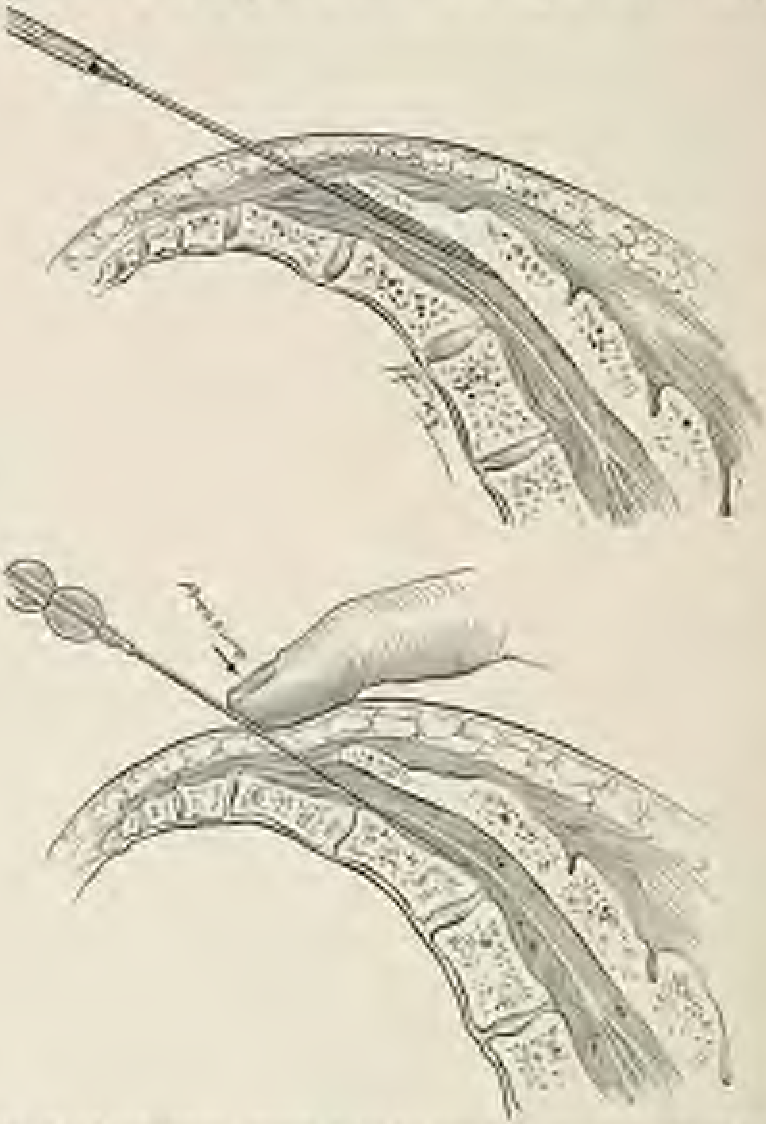

Fig. 212.—Caudal block. Simple device for introducing the needle into the sacral canal. Pressure at the site of puncture is alternately applied and released so as to prevent the needle from striking either wall of the canal.

part of the shaft inside the canal moves freely in opposite direction when the hub outside is oscillated sideways, which is not the case if

the needle lies on the posterior aspect of the sacrum. The injection of the anesthetic fluid into the sacral canal needs no pressure and gives the impression of being made in a free space or in another fluid.

Anesthetic Solution.—Novocain hydrochlorid is the anesthetic drug universally employed; the addition of adrenalin (surrenin, epinephrin,

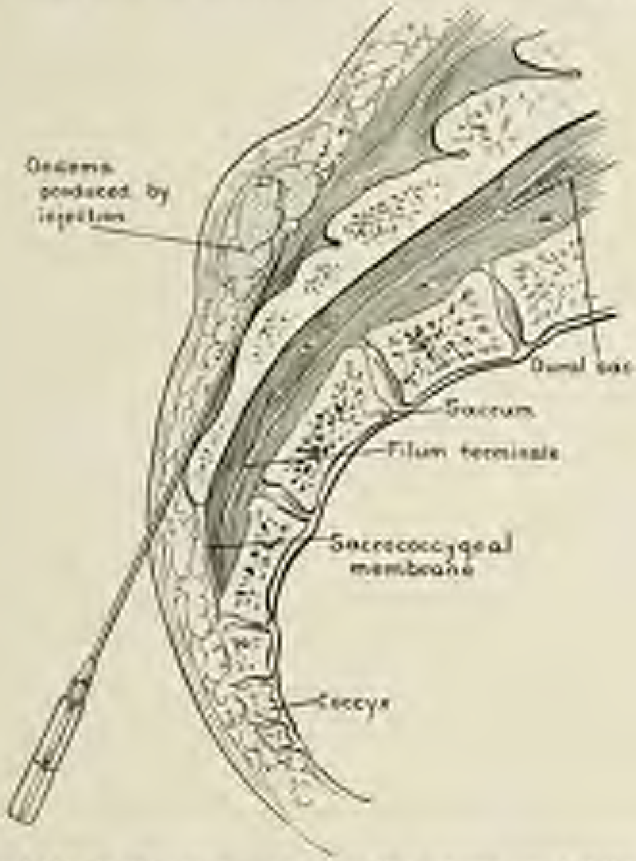

Fig. 213.—Caudal block. The edema produced on the posterior aspect of the sacrum is the undeniable proof that the needle has not been introduced into the sacral canal.

suprarenin, etc.) to its solutions is invariably recommended. Läwen adds sodium bicarbonate to the novocain hydrochlorid in order to obtain a novocain bicarbonate solution which is said to be more active than the novocain hydrochlorid solution. He uses from 20 to 25 c.c. of a 2 per cent. solution, or 40 to 50 c.c. of a 1.5 per cent. solution, and claims that the anesthesia induced is superior to that following the

injection of the plain novocain hydrochlorid solution. His solutions are composed as follows:

	2 per cent. solution.	1.5 per cent. solution.
Sodium bicarbonate (pure)	0.15	0.20
Sodium chlorid	0.10	0.20
Novocain hydrochlorid	0.60	0.75
Distilled water	50.00	50.00

The powder is dissolved in cold water and allowed to boil, after which 5 drops of adrenalin solution (1 : 1000) are added before the injection is made. J. E. Thompson uses calcium chlorid in 50 per cent. solution, adding 10 drops of that solution to 30 c.c. of the 2 per cent. novocain-adrenalin solution. Lewis and Bartels have, at a certain time, injected from 40 to 90 c.c. of equal parts of a 1 per cent. novocain solution and of a 1 per cent. potassium sulfate solution, to which 2 drops of adrenalin solution (1 : 1000) were added to each 30 c.c. of the combined solution. They later on advised the 0.5 per cent. solution in preference to half the quantity of the 1 per cent. solution. Meeker injected 20 c.c. of the 2 per cent. novocain solution with 5 drops of adrenalin solution (1 : 1000), ¾ per cent. sodium chlorid and ¼ per cent. sodium bicarbonate, and states that the clinical results are the same as with pure novocain-adrenalin solution. Braun, Kehrer, Fischer, Härtel, Schweitzer, and many others are familiar with the results obtained by the use of these combinations. Their personal experience and that of the author tend to infer that the marked advantage attributed to the drugs used as adjuncts to novocain hydrochlorid is perhaps overestimated. The injection of the 2 per cent. novocain solution must not exceed from 30 to 40 c.c., according to the general condition of the patient, and, in weak patients, be reduced to 20 c.c. From 40 to 60 c.c. of the 1 per cent. solution may be used; but the results are not as satisfactory as with the 2 per cent. solution, when the injection is intended for surgical purposes. Adrenalin must be used cautiously in the sacral canal, owing to the high absorptive power of the vessels of the epidural space, the usual dose of 15 drops being reduced to 8 drops per 100 c.c. of the novocain solution.

Reaction of the Patient.—All patients react more or less to the injection of novocain-adrenalin solutions into the sacral canal, the severity

of the reaction being proportional to the strength of the solution used, the quantity of adrenalin added to the novocain solution, the quantity of solution injected, and the velocity with which the injection is made. Rapid pulse and palpitation of the heart are the most frequent symptoms, which are occasionally followed or accompanied by an increase in the respiration rate and labored breathing. These symptoms start during the injection and last but from two to three minutes, clearing up without actual treatment, if the injection is stopped for a while and resumed very slowly. In very weak patients it is customary to inject a dose of stimulant (page 28) before the injection is resumed, but it must be borne in mind that such patients are already poor surgical risks and need very intelligent care. The severe toxic symptoms and occasional fatalities reported were due not only to poor technic in the course of which intravenous or intraspinal injections might have unconsciously been made, but occurred when a high epidural anesthesia was sought for as a substitute for spinal anesthesia. According to the author's personal experience there are no ill-effects connected with the caudal or epidural block, even when it is associated with the transsacral and the lumbar block, provided the correct technic is used and the anesthesia restricted to the pelvic organs.

SACRAL BLOCK

Sacral block is the association of the caudal block with the transsacral block. Injection is made into the sacral canal of 20 to 30 c.c. of the 1 per cent. solution, according to the extent and duration of anesthesia desired, immediately followed by the transsacral block (page 260) with the same solution. The caudal injection establishes favorable conditions for the necessary manipulations of the transsacral block which are thus rendered almost painless. When the anesthetic procedures have been completed, their combined action results in a very deep anesthesia lasting from two to four hours. The operation can be began immediately after the last injection. Its indications are similar to those of the transsacral block. One of the greatest advantages of the sacral block is the dilatation of the anal sphincter, which is half-way when the operation is begun, and only needs the application

of moderate pressure with the thumbs to be complete. Instrumental dilatation is not advised after a sacral block. Postoperative pain is greatly reduced in the majority of cases.

Blocking of the Branches of the Sacral Plexus

SCIATIC BLOCK

(Blocking of the Sciatic Nerves)

The great sciatic nerve leaves the pelvis through the great sacrosciatic foramen below the pyriformis muscle, turns downward between the great trochanter and the tuberosity of the ischium, and enters the thigh beneath the lower margin of the gluteus maximus muscle. It lies under cover of the hamstring muscles, and, on reaching the popliteal space, sometimes a little higher up, divides into external and internal popliteal nerves. It gives off branches to the posterior region of the thigh before entering the popliteal space, where it becomes subfascial. If the division takes place at the apex of the sacral plexus, or between the great sacrosciatic foramen and the popliteal space, both nerves run side by side until they reach the upper extremity of the popliteal space, where each of them takes a separate course.

External Popliteal Nerve.—The external popliteal nerve leaves the great sciatic nerve, or the internal popliteal nerve, at the upper extremity of the popliteal space and follows the tendon of the biceps, gradually running outward between the tendon and the outer head of the gastrocnemius. It then passes over the latter and reaches the head of the fibula, beneath the deep fascia, winds around the fibula, and at a distance of from 2 to 3 cm. below its head divides into its terminal branches, the anterior tibial and musculocutaneous nerves. While still in the popliteal space the external popliteal nerve gives off the recurrent articular, the sural, and the peroneal communicating nerve.

The *anterior tibial nerve* separates from the external popliteal nerve below the head of the fibula, on the lateral aspect of the bone, covered by the peroneus longus muscle. It crosses obliquely frontward and inward, passing beneath the extensor proprius hallucis and the extensor longus digitorum, and reaches the anterior aspect of the leg on the

anterior surface of the interosseous membrane. It accompanies the anterior tibial vessels and becomes superficial at the ankle, where it lies in the interval between the deep fascia and the tibia. On reaching the ankle the anterior tibial nerve passes obliquely outward beneath the tendon of the extensor proprius hallucis and follows its course on the dorsal aspect of the foot in the interval between the tendons of the extensor proprius hallucis and extensor longus digitorum. It gives off muscular branches to the tibialis anticus, the extensor longus digitorum, the extensor proprius hallucis and the peroneus tertius, and articular branches which are distributed to the forepart of the ankle-joint. Its terminal branches supply the contiguous sides of the great and second toes, contribute to the sensory innervation of the dorsal interosseous muscles and the adjacent articulations, and inosculate with the branches of the musculocutaneous nerve.

The *musculocutaneous nerve* continues the course and direction of the external popliteal nerve on leaving the anterior tibial nerve below the head of the fibula. It descends in the septum between the peroneal muscles and the extensor longus digitorum, gradually approaching the inner surface of the deep fascia, which it pierces anterior to the fibula in the lower third of the leg.

It then passes on the dorsal aspect of the foot as a single nerve or as two branches which are distributed to the lower third of the leg, the dorsum and inner side of the foot (except the contiguous sides of the great and second toes), and inosculate with the branches of the anterior tibial and external saphenous nerves.

Internal Popliteal Nerve.—The internal popliteal or tibial nerve arises from the trunk of the great sciatic nerve at the level of the upper extremity of the popliteal space, emerges from beneath the hamstring muscles and takes a downward course through the middle of the popliteal space, to the outer side of the popliteal vessels, gradually crossing them superficially from without. The popliteal artery lies deeper and a little more inward than the vein. The internal popliteal nerve gives off articular branches (knee-joint), muscular branches (gastrocnemius, soleus, plantaris, and popliteus), and a cutaneous branch, the tibial communicating nerve, which inosculates with the peroneal communi-

cating nerve (branch of the external popliteal nerve), to form the external or short saphenous nerve which contributes to the sensory innervation of the lower third of the posterolateral aspect of the leg, the lateral aspect of the ankle, and the lateral margin of the foot and fifth toe. On reaching the lower margin of the popliteus muscle the internal popliteal nerve becomes the posterior tibial nerve.

The *posterior tibial nerve* runs down the posterior region of the leg beneath the soleus and gastrocnemius muscles, accompanied by the tibial vessels, and wrapped in a common sheath. It continues its course, passes behind, then below the internal malleolus, and reaches the foot, where it divides into internal and external plantar nerves which are distributed to the structures of the sole of the foot and toes. Above and behind the ankle the posterior tibial nerve lies beneath the deep fascia, to the outer side of the vessels. Its branches are articular (ankle-joint), muscular (tibialis posticus, soleus, flexor longus hallucis and flexor longus digitorum), calcanean (skin of the medial aspect of the heel and posterior portion of the sole), and terminal (internal and external plantar nerves).

Small Sciatic Nerve.—(See page 256.)

The practical considerations brought out by the foregoing description may be summarized as follows:

1. The sciatic nerves (great and small) have a single point of emergence from the pelvis through the great sacrosciatic foramen, viz., beneath the lower margin of the pyriformis muscle. They both pass between the tuberosity of the ischium and the great trochanter, and can therefore be reached from a single point of entrance.

2. The sciatic nerves (great and small) supply the posterior region of the thigh and the entire leg and foot from a little below the knee, except the integument covering the anteromedial aspect of the leg and the inner margin of the foot.

3. The small sciatic nerve is subfascial the whole length of the thigh and cannot be blocked by subcutaneous injections.

4. The popliteal nerves part at the upper extremity of the popliteal space, beneath the deep fascia. Both can be injected through a single site of puncture.

5. The internal popliteal nerve passes along the vertical diagonal of the popliteal space and lies superficially to the outer side of the popliteal vessels.

6. The external popliteal nerve follows the posterior margin of the tendon of the biceps and can be blocked separately.

7. The external popliteal nerve divides into its terminal branches (anterior tibial and musculocutaneous nerves) below the head of the fibula, on the lateral surface of the bone.

8. The posterior tibial nerve becomes superficial behind the ankle, where it lies beneath the deep fascia to the outer side of the tibial vessels.

9. The anterior tibial nerve becomes superficial on the anterior aspect of the ankle, where it lies on the anterior surface of the tibia, either medial or lateral to the tendon of the extensor proprius hallucis.

GREAT SCIATIC BLOCK

(Blocking of the Great Sciatic Nerve)

Technic.—The position of the patient is almost that of Sims, lying on the side opposite the one to be injected, with the knee on that side

Fig. 214.—Great sciatic block. Position of patient and point of injection.

brought toward the face just enough to allow the thigh to be flexed at an angle of about 135 degrees on the trunk (Fig. 214). In this position the axis of the femur passes through the posterior superior iliac spine. The upper extremity of the great trochanter and the said iliac spine are defined by palpation and traced on the skin. The straight line joining these points (iliotrochanteric line) marks the upper margin

of the pyriformis muscle and likewise the upper border of the great sacrosciatic foramen. This line is traced and bisected. A perpendicular is raised at the point of bisection and drawn downward and inward, on which a point is taken 3 cm. distant from the iliotrochanteric line (Fig. 215). This point is the site of puncture of the great sciatic nerve, and corresponds to the exit of the nerve from the pelvis. The small sciatic nerve lies on the posterior aspect of the great sciatic nerve and is reached from the same point of entrance. Needle No. 4 (10 cm.)

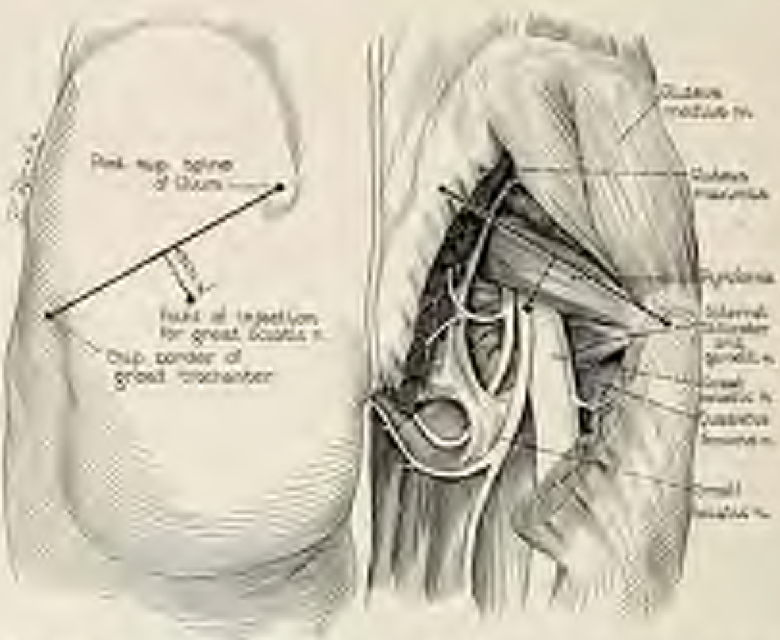

Fig. 215.—Great sciatic block. The superficial landmarks in relation to the deep structures. Note the situation of the small sciatic nerve which is blocked at the same time as the great sciatic nerve.

is inserted through a wheal raised at the said site of puncture and advanced in a direction perpendicular to the surface of the skin until its point reaches the bone at a depth of from 6 to 8 cm. according to the weight of the patient. The needle touches the bone at the level of the spine of the ischium in the majority of cases; but paresthesias are very frequently induced before the bone is felt, so that the needle must be pushed in gently and gradually as soon as 5 cm. of its shaft

have disappeared within the structure of the gluteal region, so as to avoid rough contact with the nerve. If no paresthesias are obtained, nor has the bone been reached at a reasonable depth, according to the experience of the operator, the needle is partially withdrawn and reintroduced a little more obliquely *upward*, then *downward*, until the nerve is located, which is easily and quickly done owing to the size of the nerve trunk. Injection is then made of 10 c.c. of the 2 per cent. solution and ten minutes allowed for the anesthesia to set in. If the superficial landmarks have been taken with great accuracy paresthesias are always induced by the first puncture; but they are not indispensable, since contact of the bone is taken at the level of the spine of the ischium, or of the tuberosity of the ischium a little below the spine, in the immediate neighborhood of both sciatic nerves. The rich adipose connective tissue of the region facilitates the diffusion of the anesthetic fluid toward the nerves.

Indications.—The great sciatic block is indicated for the reduction of Pott's fracture and for operations on the posterior region of the thigh. It may be induced for operations on the lateral aspect of the leg and foot; but it is very seldom resorted to for such operations, since other procedures exist for low anesthesia. It is more frequently associated with the blocking of the external cutaneous, anterior crural, and obturator nerves for the anesthesia of the lower extremity from about the level of Scarpa's triangle. The great sciatic block finds also an indication in the treatment of sciatica of the truncal type.

POPLITEAL BLOCK

(Blocking of the Internal and External Popliteal Nerves)

Technic.—With the patient lying on his stomach, both legs in extension, the popliteal space is defined and its upper limits (semimembranosus and biceps muscles) traced on the skin. The angle formed by the two lines thus traced is bisected and a wheal raised on the bisecting line about 7 cm. above the bend of the knee-joint. Needle No. 2 (5 cm.), or the next in size, according to the weight of the patient, is introduced through the wheal and advanced in a direction perpendicu-

lar to the surface of the skin until its point has passed the deep fascia. It is then gently and gradually advanced from 1 to 1.5 cm. further, where 5 c.c. of the 2 per cent. solution are injected, as soon as pares-

Fig. 216.—Popliteal block. Posterior tibial block. The garter (zone of subcutaneous infiltration) is illustrated on the right side.

thesias are induced. In the absence of radiating sensations by a fast puncture the needle is partly withdrawn, until its point becomes subfascial, and reintroduced slightly outward, then inward, and the nerve

thus located. Care should be exercised, when advancing the needle inward, not to go too deeply on account of the popliteal vein which lies just medial to the nerve. The popliteal space is filled with fat through which the anesthetic fluid can diffuse easily, so that the injection of 10 c.c. of the 2 per cent. solution made in the immediate vicinity of the nerve proves satisfactory; but the anesthesia takes more time (ten minutes) to set in.

It occasionally happens that both popliteal nerves are reached at that level by a single injection (Fig. 216), as evidenced by the territory anesthetized. Otherwise the needle is passed from the same site of puncture beneath the skin and advanced outward toward the biceps, until its point reaches the posterior margin of that muscle. The nerve is sought for subfascially and injection made of 5 c.c. of the 2 per cent. solution as soon as paresthesias are induced.

These nerves can also be injected from a point of entrance placed on the posterior margin of the biceps muscle, at a distance of about 4 fingerbreadths (7 cm.) above the bend of the knee-joint. After injecting the external popliteal nerve the needle is passed subcutaneously inward, gradually piercing the deep fascia, until its point lies in the sagittal plane of the bisecting line already alluded to, where the internal popliteal nerve is sought for at a depth slightly greater than that at which the external popliteal nerve was found. The region must not be traumatized by repeated punctures made at random. After a few trials to reach the nerve, 10 c.c. of the solution are injected and the region gently massaged.

Indications.—The popliteal block is indicated for operations on the calf, the peroneal muscles, and the lateral half of the foot. Associated with a subcutaneous ring of infiltration around the leg called "the garter" (Fig. 216), its indications are extended to the whole leg and foot.

EXTERNAL POPLITEAL BLOCK

(Blocking of the External Popliteal Nerve)

The external popliteal nerve, as already seen, follows the posterior margin of the biceps muscle and continues its course between the

tendon of the biceps and the outer head of the gastrocnemius. It passes over the latter and winds around the fibula at a distance of from 2 to 3 cm. below its head, where it divides into its terminal branches. The external popliteal nerve can, therefore, be reached at any level along the posterior margin of the biceps, or at the fibula. In

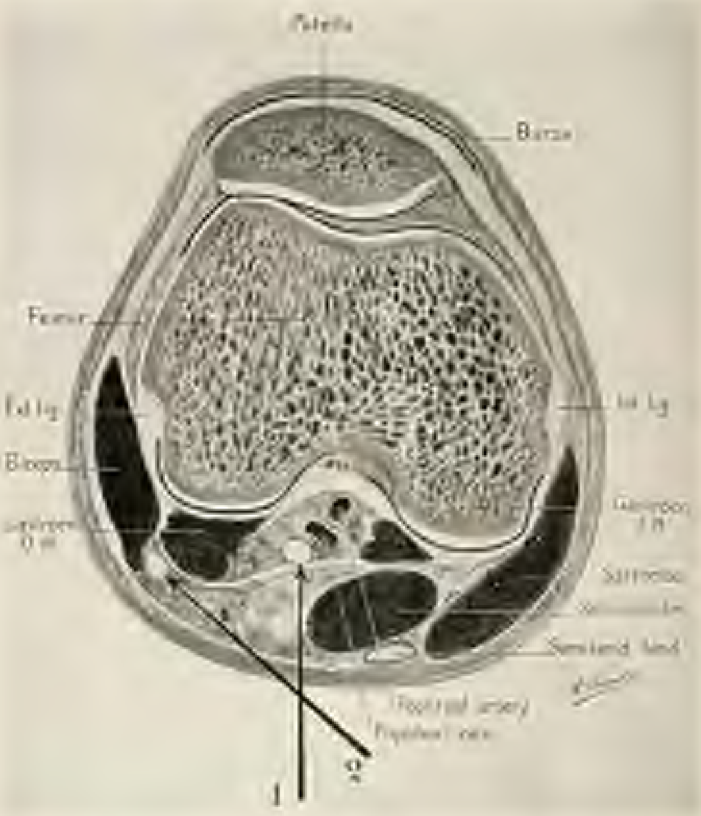

Fig. 217.—Internal and external popliteal block. Cross-section of the knee through the patella: 1, Internal popliteal nerve; 2, external popliteal nerve.

the first case, it is preferable to choose a point of entrance either at or slightly higher than the bend of the knee, since the nerve there lies more superficially than elsewhere. In lean patients the nerve can be felt at that level rolling under the palpating finger, and radiating sensations may be induced by the application of pressure.

External Popliteal Block at the Popliteal Space.—With the patient lying on his stomach, the tendon of the biceps is defined on the line marking the bend of the knee. Needle No. 2 (5 cm.) is inserted through a wheal raised just medial to the tendon, at or slightly higher than the bend. Soon after piercing the deep fascia paresthesias are induced in the lower part of the lateral aspect of the leg and on the dorsum of the foot. Injection is then made of 5 c.c. of the 2 per cent. solution without moving.

Fig. 218.—External popliteal block at the fibula. The supramalleolar bracelet (zone of subcutaneous infiltration) is illustrated on the right side.

External Popliteal Block at the Fibula.—With the patient lying on the side opposite the one to be injected, knee flexed, the head of the fibula is defined by palpation and a wheal raised in the depression felt just below it (Fig. 218). Needle No. 2 (5 cm.), already connected with the syringe, is introduced through the wheal and advanced transversely toward the bone which is met after piercing the peroneus longus muscle. If no paresthesias are induced by the first puncture, the solution is distributed fanwise in close contact with the bone, on a length of about

5 cm. using 5 c.c. of the 2 per cent. solution. In case the nerve is hit, the injection is made, as usual, without displacing the needle.

Indications.—Associated with "the garter" (page 316) the external popliteal block is indicated for operations on the anterolateral region of the leg, the anterior aspect of the ankle, and the dorsum of the foot; but the anesthesia does not extend to the lateral margin of the foot, partly innervated by the saphenous nerve which receives contributions from the internal popliteal nerve.

ANTERIOR TIBIAL BLOCK

(Blocking of the Anterior Tibial Nerve)

The patient lies on his back, with the lower extremity on the side to be injected flexed, so that the sole of the foot may rest on the table

Fig. 219.—Anterior tibial block.

as near its edge as possible (Fig. 219). A line is drawn around the ankle at the base of the internal malleolus and a wheal raised on this line on the lateral margin of the tendon of the tibialis anticus. Needle No. 2 (5 cm.), connected with the syringe, held like a penholder, is intro-

duced through the wheal and advanced in a sagittal direction until its point impinges on the tibia. The needle is drawn backward about 2 mm. and injection made of 5 c.c. of the 1 per cent. solution, without moving, while the point of the needle still lies between the deep fascia and the bone.

As already seen (page 286), the anterior tibial nerve approaches the ankle in a direction slightly inclined downward and outward; so that it has, at the ankle, positions which vary with the level considered and adopted by the operator. The anterior tibial nerve may, therefore, occupy one of the three following positions: (1) The interval between the tibialis anticus and the extensor proprius hallucis, (2) beneath the extensor proprius hallucis, and (3) the interval between the extensor proprius hallucis and the extensor longus digitorum.

If the nerve is not reached in the sagittal plane of the ankle passing through a point to the outer side of the tendon of the tibialis anticus, it is advisable to inject 3 c.c. of the 1 per cent. solution over the anterior surface of the tibia, in the sagittal plane just mentioned, and after partially withdrawing the needle to change its direction, pass the needle obliquely outward between the tendons of the extensor hallucis and extensor longus digitorum and deposit 3 c.c. more of the same solution over that part of the tibia. The areolar tissue overlying the anterior aspect of the bone allows the solution to diffuse to the nerve when it lies beneath the extensor hallucis.

The anterior tibial block being always associated with the posterior tibial block, the region is massaged and the blocking of the posterior tibial nerve begun.

POSTERIOR TIBIAL BLOCK

(Blocking of the Posterior Tibial Nerve)

With the patient lying in the same position as for the anterior tibial block (Fig. 220) or, better, with the leg on the side to be injected flexed and crossed over the other leg, the needle is passed through a wheal raised to the inner side of the tendo achillis on the line already traced around the ankle, and advanced horizontally toward the posterior aspect of the tibia in a direction slightly inclined outward. After piercing the

deep fascia the needle travels freely through fat, then encounters the resistance of a deeper fascia which must be overcome so that the solution may be distributed in close proximity to the nerve. Paresthesias are sought for by a few punctures made in the direction of the sagittal plane of the ankle. If they cannot be induced, it is sufficient to deposit

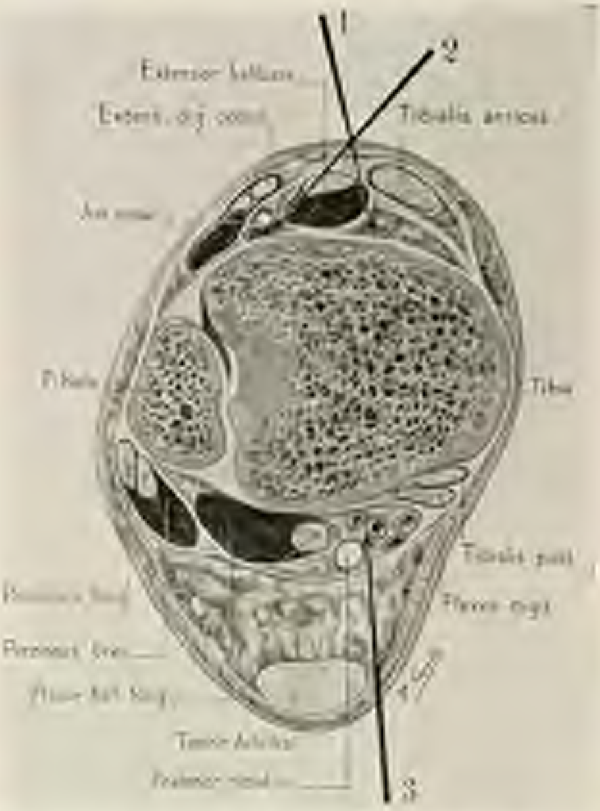

Fig. 220.—Cross-section through the ankle just above the joint: 1 and 2, Anterior tibial block; 3, posterior tibial block.

the solution beneath the deeper fascia, in the fat surrounding the nerve, using 5 c.c. of the 1 per cent. solution. Five minutes are allowed for the anesthesia to set in.

Indications.—The posterior tibial block is associated with the anterior tibial block for operations on the foot; but a ring of subcutaneous infiltration must be made along the line traced around the

Fig. 221.—Posterior tibial block.

ankle, so as to cut off the superficial innervation of the margins of the foot.

CHAPTER VI

OPERATIONS ON THE NECK

The anterior and lateral regions of the neck are practically the only surgical areas of that part of the body in which regional anesthesia is very satisfactory. Operations in these regions are divided into four groups:

1. Operations on the thyroid vessels and gland.
2. Operations on the trachea and larynx.
3. Excision of the lymphatic glands of the neck.
4. Other operations, such as ligation of the carotid and lingual arteries, excision of branchial cysts, etc.

OPERATIONS ON THE THYROID VESSELS AND GLAND

Ligation of the thyroid vessels is ordinarily performed by local infiltration of the line of incision. This procedure is easily and quickly accomplished, and is just the type of anesthesia which befits that category of patients in whom ligation is indicated as a preliminary operation. The solution must be distributed subcutaneously and subfascially, so as to expose painlessly the upper pole of the gland. If the deep manipulations are still painful, some more of the anesthetic fluid is injected on both sides of the pedicle before ligation. The 0.5 per cent. solution is very satisfactory, and should be used without the addition of adrenalin.

Thyroidectomy is painlessly performed after the cervical plexus block by the lateral route (page 74), associated with the subcutaneous infiltration, as illustrated in Fig. 223, which partially controls the hemorrhage. The cervical plexus block gives a complete relaxation of the muscles of the neck, with greater facility for the use of retractors. Blocking the superficial branches of the cervical plexus along the posterior margin of the sternocleidomastoid muscle is less satisfactory, because the nerve supply of the muscles originates from the

deep cervical nerves. Circumferential infiltration around the gland, as practised by many surgeons, reduces bleeding to a minimum, but does not anesthetize the deeper structures in which the solution must, as a rule, be distributed in the course of the operation. The practice of injecting along the line of incision and within the structures of the

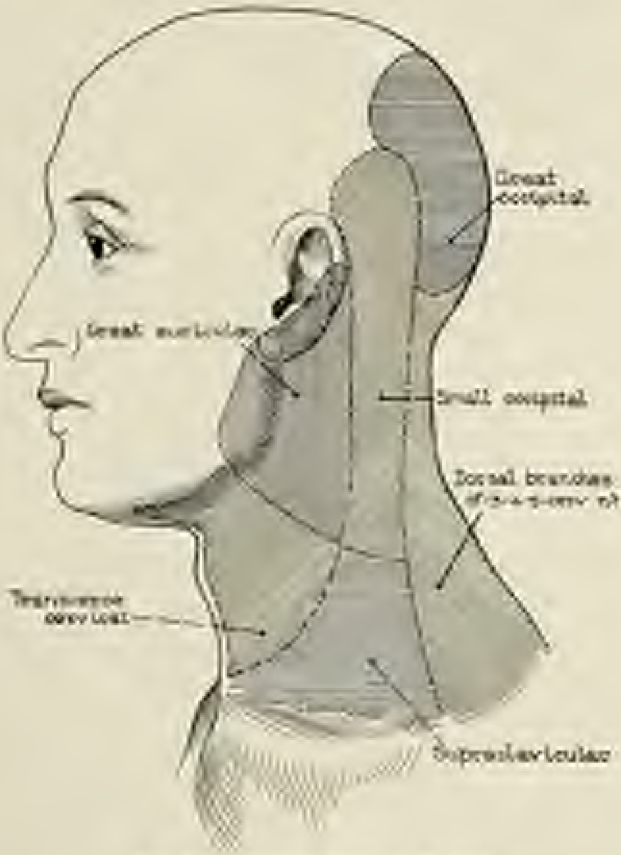

Fig. 222.—Sensory areas of the neck.

surgical wound is objectionable on account of the defective healing which ensues in about 20 per cent. of cases. It is also a very unsafe procedure to inject the thyroid region profusely and at random, with the needle previously connected with the syringe. The solution can thus be unconsciously injected into the blood-stream and give rise to toxic symptoms. In simple goiter cases, 10 drops only of adrenalin

solution (1 : 1000) are added to 100 c.c. of the novocain solution, and in exophthalmic goiter no adrenalin is used.

Notwithstanding the intensity of the anesthesia present after the cervical plexus block, pulls on the gland are interpreted by the patient as a "choking sensation." They should, therefore, be moderate and

Fig. 223.—Cervical plexus block for thyroidectomy. The cervical nerves are injected close to the spine through a single point of entrance 1, as shown by the arrows. Subcutaneous injections are finally made joining 1-2-3-2'-1', the last point being, on the right side of the neck, the homologue of 1.

gradual. The association of gas analgesia with regional anesthesia, according to Crile's principles, is here of the highest value. The psychic element is thus considerably reduced, if not abolished, and the operative prognosis greatly improved.

OPERATIONS ON THE TRACHEA AND LARYNX

In all operations on the upper air-passages it is necessary to abolish the irritability of the mucosa and prevent coughing. This is done by the intratracheal or intralaryngeal instillation of a strong solution of cocain either before or in the course of the operation; but it is preferable to complete the anesthesia before the operation is begun.

Tracheotomy.—With the patient in the horizontal dorsal position, head in moderate extension so as not to increase the discomfort due to

Fig. 224.—Field-block for tracheotomy: f and f' are the sites of puncture for circuminjecting the trachea; a, the point of entrance of the needle for instillation into the laryngeal cavity.

labored breathing, the anesthesia is begun by the infiltration of a little rhombus of which the greater diagonal is the intended line of incision. Through two wheals, raised one on each side of the trachea, the deeper structures are injected in a line corresponding to the sides of the rhombus (Fig. 224), after which the needle is passed beneath the skin and a subcutaneous injection made along those sides, using a total of 20 c.c. of the 0.5 per cent. solution. The midline of the trachea and

larynx is thus free from the edema otherwise produced by the injection of the anesthetic fluid along the line of incision, and the cricothyroid space can be easily palpated. The upper margin of the cricoid cartilage is defined by the left forefinger and needle No. 2, already connected with the 2 c.c. syringe filled with a 10 per cent. cocain solution, inserted at the tip of the finger exactly on the midline and advanced in a direction perpendicular to the surface of the skin, until 1 cm. of its shaft has disappeared. The needle must be pushed in without hesitation, since the thickness of the tissues at that level is at least 1 cm., although

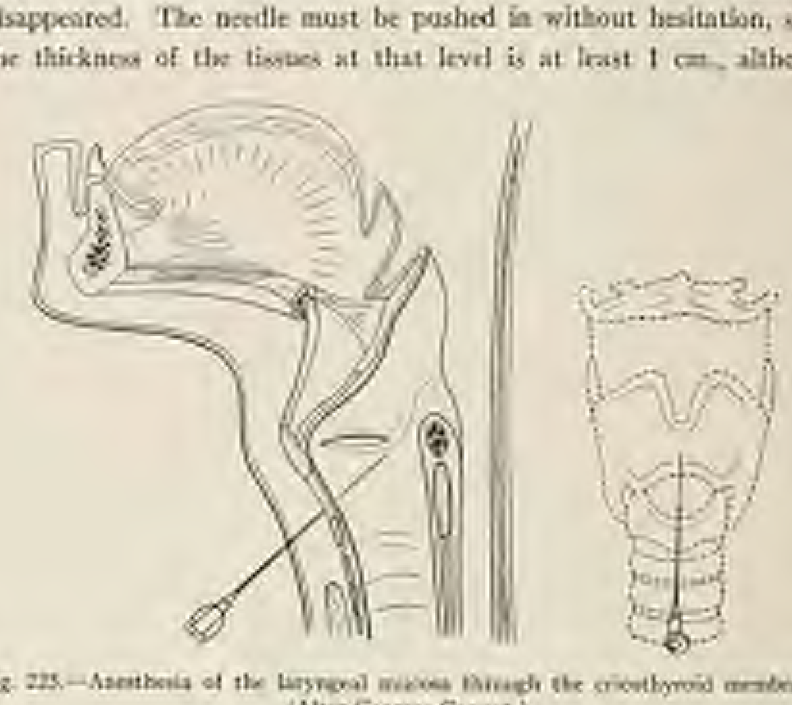

Fig. 225.—Anesthesia of the laryngeal mucosa through the cricothyroid membrane (After Georges Canuyt.)

varying with the adiposity of the region. The cricothyroid membrane offers a peculiar resistance which is overcome just before the point of the needle reaches the laryngeal cavity, in which it can be made to move in all directions. A curved needle may be used for these intratracheal instillations; but the usual regional anesthesia straight needle serves as well. For the anesthesia of the laryngeal portion of the mucosa, the patient is placed in Rose's position, the needle is directed upward, and the solution injected drop by drop until the 2 c.c. syringe is discharged (Fig. 225). The solution spreads all over the mucosa and

produces the desired result. The patient should not be allowed to move, speak, or cough during the injection. If it is necessary to anesthetize the tracheal portion of the mucosa, the needle is directed downward and the instillations made in a similar manner (Fig. 226). In puncturing the cricothyroid membrane care should be exercised not (*a*) to create a false passage sideways, (*b*) to avoid puncturing the posterior wall of the larynx, and (*c*) to prevent the needle from being displaced or thrown out during a sudden deglutition (Georges Canuyt). The puncture of the cricothyroid membrane may be made after ex-

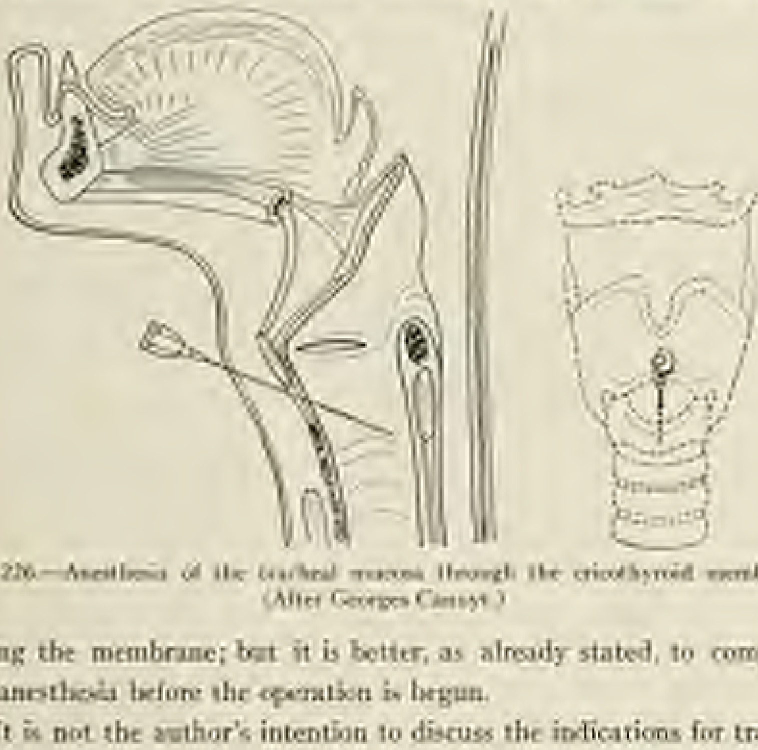

Fig. 226.—Anesthesia of the tracheal mucosa through the cricothyroid membrane. (After Georges Canuyt.)

posing the membrane; but it is better, as already stated, to complete the anesthesia before the operation is begun.

It is not the author's intention to discuss the indications for tracheotomy as an operation. In emergency cases the sole object is to save the patient's life. Anesthesia is of no use, since sensibility is already greatly diminished by the state of shock in which the patient is. But it is perfectly clear that inhalation narcosis, especially ether, is absolutely contraindicated in all cases of stenosis of the air-passages, whatever be its cause.

Thyrotomy.—With the patient lying in the same position as for

tracheotomy, head a little more in extension, a rhombus is infiltrated from two points of entrance one on each side of the larynx, as illustrated in Fig. 227. The deep structures are first infiltrated and then the subcutaneous tissue along the sides of the rhombus. A wide anesthetic area is thus produced from the lower border of the hyoid bone to the first tracheal ring, without any distortion of the anatomic features along the line of incision. Intratracheal instillations are then made according to Canuyt's technic described on page 304, distributing the solution

Fig. 227.—Field-block for thyrotomy: I and I' are the points of entrance of the needle for the injection of the soft structures in the direction of the arrows; a, the site of puncture for instillation into the laryngeal cavity.

upward and downward on the mucosa. The circumferential infiltration or field-block takes about 30 c.c. of the 0.5 per cent. novocain-adrenalin solution, while the intratracheal instillations require only 2 c.c. of a 10 per cent. cocain solution. Ten minutes are allowed for the anesthesia to set in.

Total Laryngectomy.—As a rule, a preliminary tracheotomy has been performed a fortnight before. The second-stage operation is performed under regional anesthesia induced in the following manner:

(*a*) The cervical plexus block (page 174) is performed on both sides.

(*b*) With the patient lying on his back and a cushion slipped under the shoulders so as to place the head in extension, a horseshoe infiltration is made subcutaneously along *B*-2'-1-2-*B* (Fig. 228) with 20 c.c. of the 0.5 per cent. novocain-adrenalin solution.

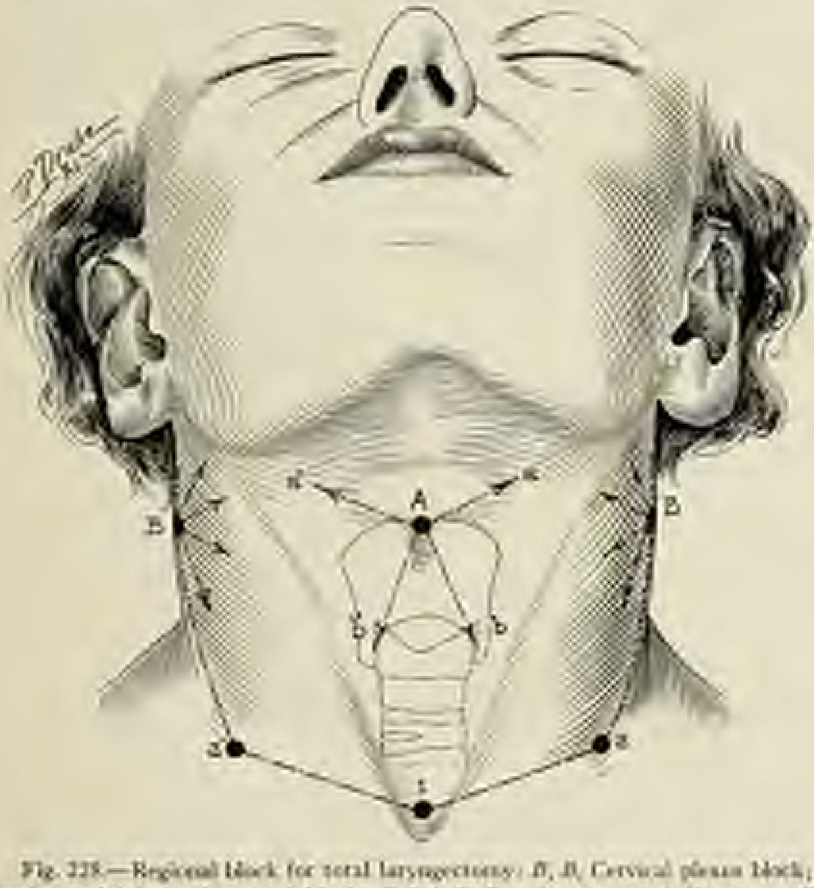

Fig. 228.—Regional block for total laryngectomy: *B*, *B*, Cervical plexus block; *A*, superior and inferior laryngeal block: *B*-2-1-2'-*B*, subcutaneous infiltration. The hypopharynx is anesthetized through *A*.

(*c*) The superior and inferior laryngeal nerves are blocked through a single point of entrance *A* (Fig. 228), according to the technic described on pages 112-117.

(*d*) The anesthesia of the hypopharynx (Fig. 229) is obtained by introducing the needle through the thyrohyoid membrane, using the

same point of entrance *A*, and instilling drop by drop 2 c.c. of a 10 per cent. cocain solution (Canuyt).

(*e*) The anesthesia of the trachea is performed by swabbing the mucous membrane with a 10 per cent. cocain solution applied through the tracheal opening.

(*f*) After preliminary rhinoscopic examination as to the permeability of the nasal cavities, one of them is anesthetized by means of an applicator moistened with a 10 per cent. cocain solution, passed beneath the inferior turbinate and advanced as far as possible backward. The esophageal sound can thus be placed with great ease.

Fig. 229.—Anesthesia of the hypopharynx through the thyrohyoid membrane. (After Georges Canuyt.)

If the cervical plexus is not blocked, the anesthesia of the larynx is obtained in the manner illustrated in Fig. 230. The position of the patient is the same as before. Through the wheals 4 and 4' the needle is advanced toward the great cornua of the hyoid bone; through 2, 3, 2', and 3' the needle is passed behind the larynx, and all the soft tissues lateral to the organ infiltrated with from 50 to 60 c.c. of the 0.5 per cent. novocain-adrenalin solution. Circumferential injections are then made subcutaneously, joining all the wheals together, and the superior laryngeal block (page 112) performed through *A*, which also serves

for the anesthesia of the hypopharynx by instillations of a 10 per cent. cocain solution, made in the manner already described (page 307). The injections carried deep behind the larynx facilitate the dissection of the organ from the esophagus.

The anesthesia produced by either of these procedures is absolute, as is readily understood; but it carries with it the paralysis of the

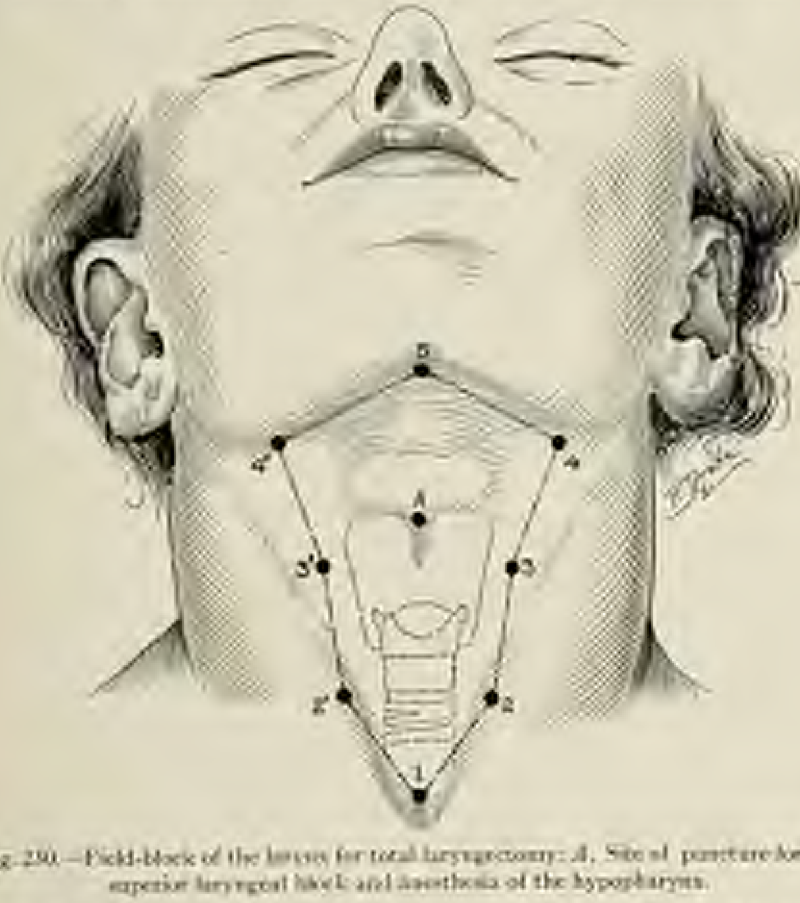

Fig. 290.—Field-block of the larynx for total laryngectomy: A, Site of puncture for the superior laryngeal block and anesthesia of the hypopharynx.

intrinsic muscles of the larynx, which results in labored breathing and asphyxia in the absence of a preliminary tracheotomy. The injections made behind the larynx produce similar results. It is therefore recommended to operate in two stages, or to be very careful when blocking both inferior laryngeal nerves for a single-stage operation, and be ready to perform the tracheotomy at the first signal, before any attempt is

made to restore breathing by artificial respiration. As soon as the patient recovers from such a condition, laryngectomy is begun and completed with no worse prognosis than if nothing had happened.

Regional anesthesia is the method of choice for total laryngectomy. It has completely changed the aspect of the operation and simplified its technic by realizing an almost dry operative field and allowing more time for a clean dissection. The operative mortality, especially due to shock and bronchopneumonia, is thus considerably reduced. Since its use in Professor Moure's clinic, Bordeaux, the death-rate has dropped from 60 to 4 per cent. (Canuyt-Rozier).

EXCISION OF THE LYMPHATIC GLANDS OF THE NECK

After blocking the cervical plexus on both sides the operative field is circumscribed by subcutaneous injections made along the posterior

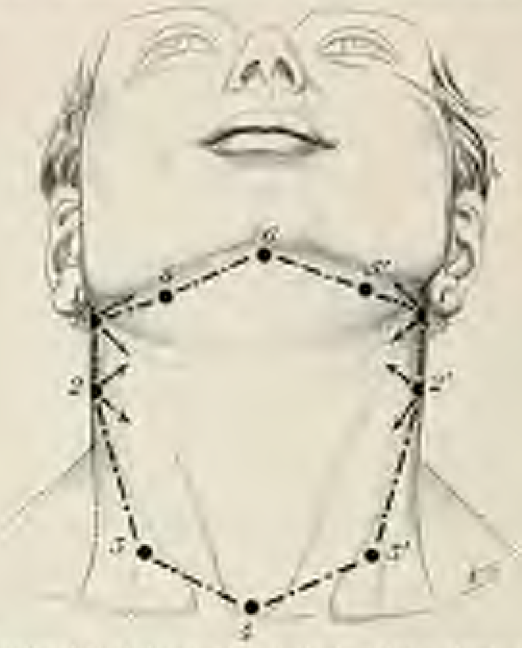

Fig. 231.—Regional block for excision of the lymphatic glands of the neck: 1-1', 2-2', Paravertebral cervical block; 5-5', sites of puncture into the submaxillary space; 1-2-3-4-3'-2'-1'-5'-6-5-1, subcutaneous circuminjection of the field.

margin of the sternocleidomastoid muscle, the clavicle and sternum, and the lower border of the lower jaw. The needle is then passed into

the submaxillary space and the solution distributed within it if the submaxillary gland is involved in the proposed operation. From 60 to 80 c.c. of the 0.5 per cent. solution is sufficient, apart from the quantity used for the cervical plexus block, 5 c.c. being injected in each submaxillary fossa. The lateral route is the procedure of choice for the cervical plexus block (page 174), provided the distortion due to the enlargement of the cervical lymph-nodes does not render the approach of the transverse processes too difficult or unsafe, in which case the injections must be made by the posterior route (page 172).

OTHER OPERATIONS ON THE NECK

For ligation of one of the carotid arteries, or of any of the blood-vessels of the neck, the cervical plexus block by the lateral route (page 174) is the best procedure. The excision of a branchial cyst, or of any other tumor of the anterior and lateral aspects of the neck, is likewise painlessly performed by blocking the cervical plexus on one side or on both sides. It is a procedure more satisfactory than the local infiltration, because it avoids the distortion of the anatomic features of the region and thus facilitates the clean dissection of the pathologic structures involved. The operative field is rendered almost bloodless by the association of subcutaneous injections of the 0.5 per cent. solution made around it.

The posterior aspect of the neck, region of furuncles and carbuncles, does not lend itself so easily to local and regional anesthesia. Its nerve supply originates from the posterior primary divisions of the cervical nerves, which are not all reached by the anesthetic fluid injected laterally. The posterior route is not available, since the region is the site of severe infection and is extremely painful. The infected and inflamed neighboring tissues are such that the use of local infiltration seems little justified. The neck is stiff; the thick, hard, and adherent skin of the neighborhood does not allow the needle to penetrate with ease, if at all. It is, therefore, preferable to have recourse to gas-oxygen anesthesia for the cautery excision of extensive furuncles and carbuncles of the posterior aspect of the neck. This is one of the exceptional cases in which local and regional anesthesia give little or no satisfaction.

CHAPTER VII

OPERATIONS ON THE UPPER EXTREMITIES

The sensory nerve supply of the upper extremities is chiefly due to the brachial plexus. Two or three of the lateral branches of the intercostal nerves contribute to the innervation of the upper portion of the inner aspect of the arm, occasionally as far as midway between the axilla and the elbow. These branches originate from D^2 and D^3, cross the axilla, and join the plexus too low to be reached by the supraclavicular or the infraclavicular injection. They therefore interfere with the anesthesia resulting from the brachial plexus block. The overlapping supraclavicular branches of the cervical nerves are likewise responsible for pain in the region of the shoulder. These nerves must, therefore, be blocked whenever the operation is extended to the above-mentioned regions.

INTERSCAPULOTHORACIC AMPUTATION

The amputation of the upper extremity, including the scapula and the external part of the clavicle, is performed by the association of the following procedures:

(*a*) Cervical plexus block by the lateral route (page 174).

(*b*) Brachial plexus block by the supraclavicular route (page 189).

(*c*) Paravertebral dorsal block from D^1 to D^8, all the injections being made on the side of the lesion only (Figs. 233, 234).

DISARTICULATION OF THE SHOULDER-JOINT

After blocking the brachial plexus by the supraclavicular route (page 189) the axilla is infiltrated in the following manner:

With the patient's arm in abduction, needle No. 4 (10 cm.), attached to the syringe filled with the 0.5 per cent. solution, is inserted through a wheal raised at the posteromedial angle of the floor of the axilla and advanced deeply upward and inward tangentially to the thoracic wall

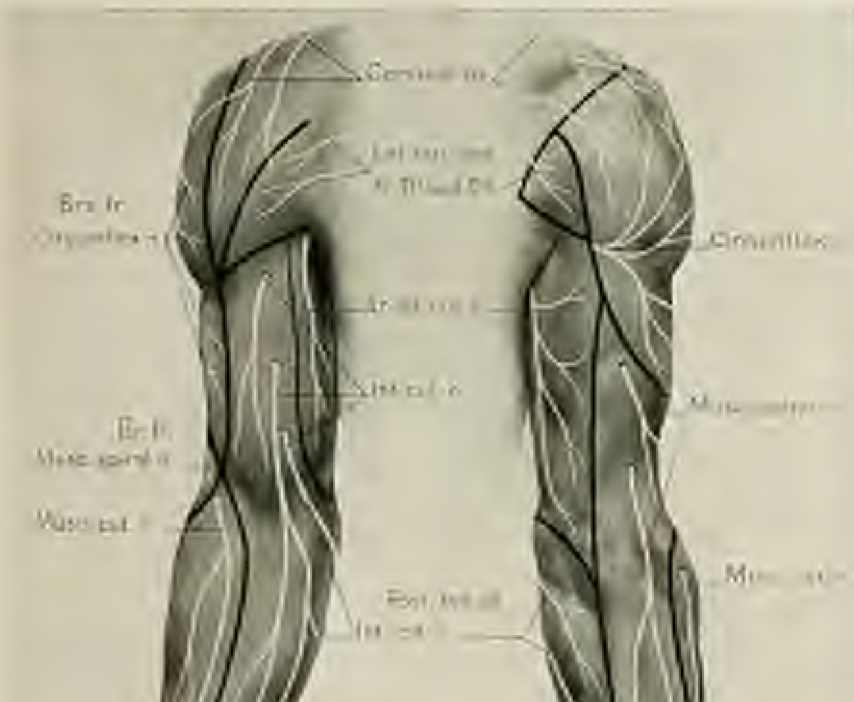

Fig. 232.—Sensory areas of the upper extremities.

of the axillary space. The needle is then partly withdrawn several times and its direction changed so as to distribute the solution fanwise over the thoracic wall. The injections are slow, steady, and continuous while the needle is advanced as well as when it is withdrawn, care being exercised not to pass the needle between two ribs and thus enter the

Fig. 233.—Regional block for interscapulothoracic amputation. Anterior aspect resulting from the blocking of cervical plexus, 1, brachial plexus, 2, and the first ten thoracic nerves on the same side.

thoracic cavity. The lateral communicating branches of the intercostal nerves are thus blocked with ease and success, using only about 30 c.c. of the 0.5 per cent. solution. The anesthesia is completed by the subcutaneous injection of 20 c.c. of the 0.5 per cent. solution at the base of the neck, along the clavicle and acromion.

When making the axillary injections it is a good practice to take contact with the ribs each time that the needle is introduced, so as to be sure to pass on their lateral aspect.

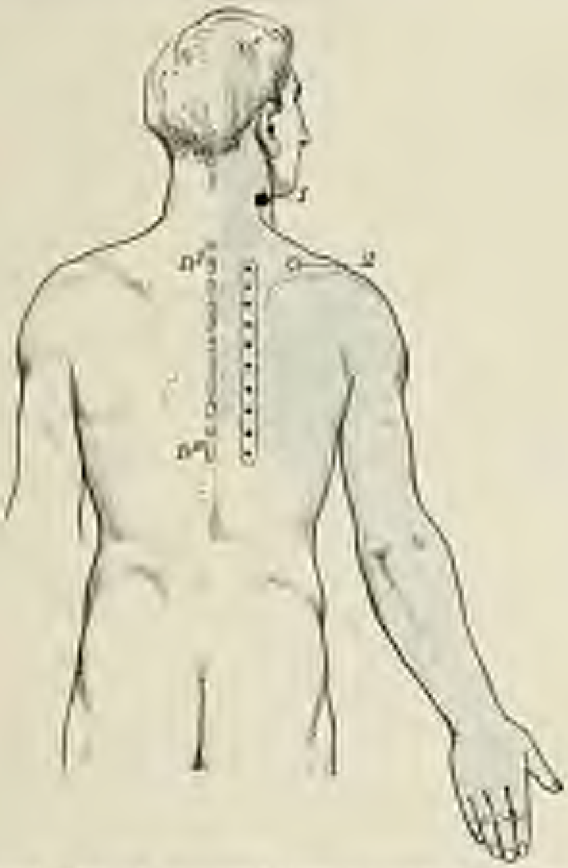

Fig. 234.—Regional block for interscapulothoracic amputation. Posterior aspect of Fig. 233.

AMPUTATION OF THE ARM

After blocking the brachial plexus by the supraclavicular route (page 189) a subcutaneous infiltration, called the "infra-axillary bracelet,"[1] is made around the arm, as illustrated in Fig. 235.

[1] For the sake of brevity the term "infra-axillary bracelet," or "deltoid bracelet," is used to denote a narrow band of subcutaneous infiltration of the 0.5 per cent. solution made around the arm just below the axilla, in a plane at right angles to the axis of the arm. Needle No. 2 (5 cm.), connected with the syringe, is passed through as many

Fig. 235.—Regional block for amputation of the arm, resulting from the brachial plexus block, 1, and the "infra-axillary bracelet," 2.

REDUCTION OF FRACTURES OF THE HUMERUS

The brachial plexus block by the supraclavicular route (page 189) is, in such cases, the procedure of choice.

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wheals as are necessary to complete the circumference of the arm at that level, and the solution distributed at the rate of 1 c.c. per 1 cm. of length of tissue in a plane at right angles to the axis of the arm.

"Supracondylar bracelet" is the name given to a similar band of subcutaneous infiltration passing through the sites of puncture of the median, musculospiral, and ulnar nerves at the elbow; "wrist bracelet," that passing through the points of entrance for the median and the ulnar block at the wrist; "garter," that made just below the tubercle of the tibia; "supramalleolar bracelet," that passing through the sites of puncture of the anterior and posterior tibial nerves at the ankle.

Local injections of the fractured extremities as used by Quénu, give satisfactory results and must be resorted to if the brachial plexus block cannot be induced. The needle must be inserted through healthy tissues, *i. e.*, where the skin is neither bruised nor soiled. It must be introduced at some distance from the large blood-vessels of the region, hence, from the external side of the arm. The injections are made with

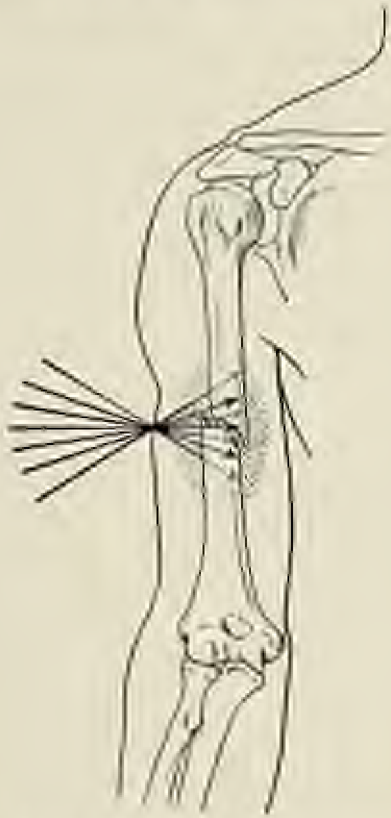

Fig. 236.—Local infiltration for a fracture of the humerus.

the 0.5 per cent. solution, of which from 100 to 150 c.c. are distributed in the immediate neighborhood of the fractured extremities, as well as at the site of the fracture itself (Fig. 236).

Fractures of the forearm are treated in the same manner before any attempt is made to examine the patient under *x*-rays or otherwise manipulate the fractured limb.

OPERATIONS ON THE AXILLA

These operations are performed by associating the brachial plexus block by the supraclavicular route (page 189) with the paravertebral dorsal block (page 214) from D^2 to D^5, and completing the anesthesia by subcutaneous injections made along the clavicle and acromion.

The axilla can also be anesthetized by blocking the brachial plexus by the axillary route (page 185) and distributing the solution fanwise over the thoracic wall of the axilla, in the manner described (page 312) for the disarticulation of the shoulder-joint. But this procedure will not be employed if the axilla is the site of an acute infection.

The circuminjection of the floor of the axilla does not result in the anesthesia of the circuminjected area, the sensory contribution brought in by the brachial plexus coming from the depth.

RESECTION OF THE ELBOW-JOINT

The brachial plexus block by the supraclavicular route (page 189) is all that is ordinarily needed for the resection of the elbow-joint. But it occasionally happens that the inner side of the arm retains some sensibility to pain a little above the elbow. This condition is more a source of discomfort than of actual pain during the surgical maneuvers. It is due to the uncontrolled communicating branches of the intercostal nerves, and can be remedied by injecting subcutaneously the entire circumference of the arm a little above the operative field, or by infiltrating the "infra-axillary bracelet" (page 315).

REDUCTION OF DISLOCATION OF THE ELBOW

The brachial plexus block by the supraclavicular route (page 189) is the method of choice for the reduction of the dislocation of the elbow. But the procedure used by Quénu may be employed if the surgeon is not familiar with the brachial plexus block or does not succeed in inducing it. The needle is introduced through various points around the elbow and advanced in different directions toward the articular extremities, care being exercised to avoid as much as possible the blood-vessels of the region. The solution is distributed over the surfaces of

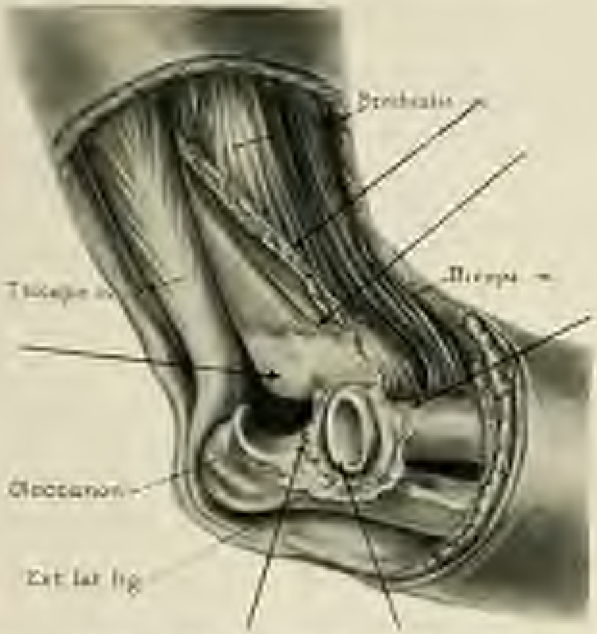

Fig. 257.—Manner of injecting the dislocated elbow. The arrows show the points of entrance and the various directions of the needle, as well as the sites of injection.

the joint as well as within the overlying soft structures, using from 100 to 150 c.c. of the 0.5 per cent. solution (Fig. 257).

REDUCTION OF FRACTURE OF THE ELBOW

The brachial plexus block by the supraclavicular route (page 189) is recommended to those who know how to give it. Local infiltration of the site of fracture will be used by the others, in the same manner as for the dislocation of the elbow; the edema produced by the injected fluid in the immediate vicinity of the fractured bones spreads out very rapidly in all directions, and with the anesthesia thus induced a condition of relaxation sets in, which renders manipulations painless.

DISARTICULATION OF THE ELBOW-JOINT

The brachial plexus block by the supraclavicular route (page 189) is the method of choice.

AMPUTATION OF THE FOREARM

This operation may be done in two ways, viz., by blocking the brachial plexus (page 189), or by associating the median, the musculo-

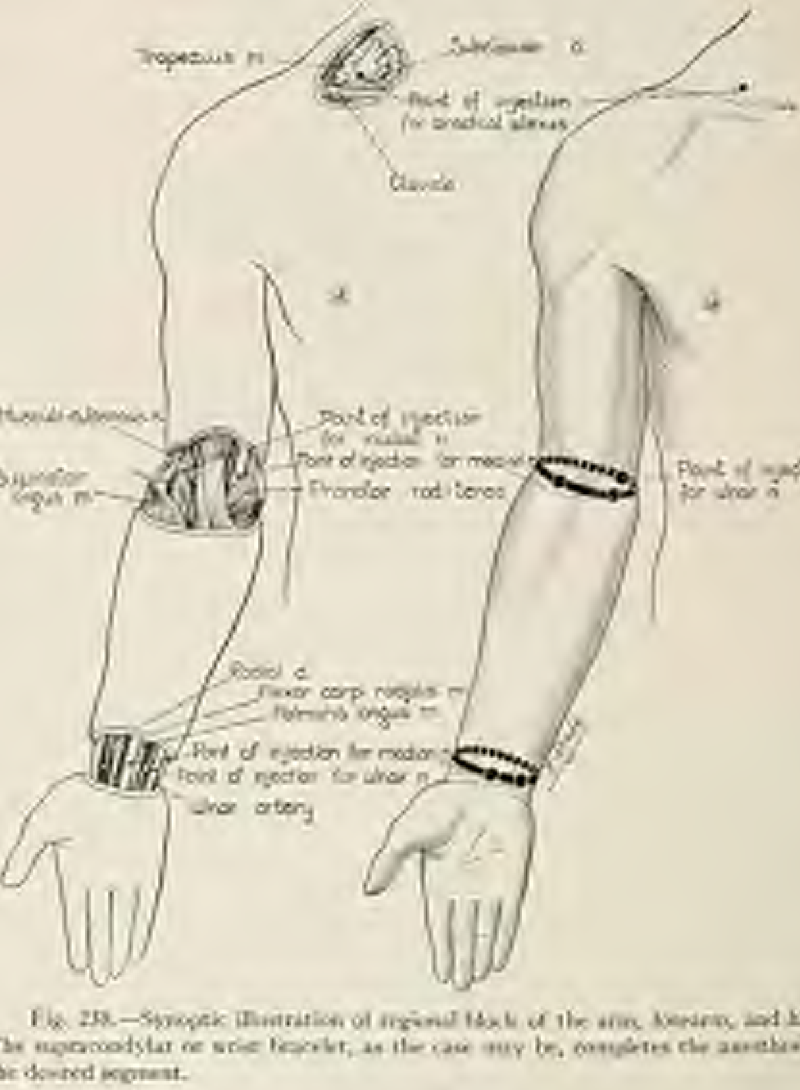

Fig. 238.—Synoptic illustration of regional block of the arm, forearm, and hand. The supracondylar or wrist bracelet, as the case may be, completes the anesthesia of the desired segment.

spiral, and the ulnar block at the elbow with the "supracondylar bracelet" (page 214). The same procedure is used for the amputation of the forearm at the wrist.

All operations involving only the skin and superficial fascia of the forearm are painlessly performed by a U-shaped field block, as illustrated in Figs. 239 and 240. The needle is introduced through two

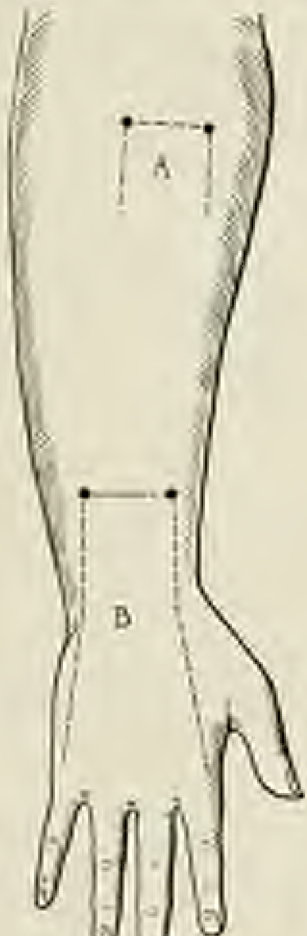

Fig. 239.—Field-block for superficial operations on the posterior aspect of the forearm (*A*). The lateral lines of infiltration may be prolonged over the wrist and dorsum of the hand (*B*).

wheals raised at some distance above the operative area, and the 0.5 per cent. solution injected first along the line joining the wheals, then along two other lines at right angles to the first and parallel with the axis of the forearm. The excision of the olecranian bursa mucosa may

Fig. 240.—Field-block for excision of the olecranian bursa mucosa. The needle is introduced through 1 and 2 and directed toward 3 and 4; 1–2 are then joined together. Also used for suture of the olecranon.

Fig. 241.—Nerve supply of the palmar region of the hand. Median and ulnar nerves.

be accomplished in the same way. For the suture of the olecranon the deeper structures also are infiltrated with the 0.5 per cent. solution, after which the needle is passed on each side of the fracture into the

Fig. 242.—Nerve supply of the dorsum of the hand. Radial and ulnar nerves.

joint and 10 c.c. of the 1 per cent. solution injected within it. Ten minutes are allowed before the operation is begun.

The skin and superficial fascia of the forearm, as far as its lower third, are supplied exclusively by the superficial nerves emerging from the deep fascia above the elbow; so that subcutaneous injections made

around the arm at the level of the condyles of the humerus are followed by the anesthesia of the superficial layers of the upper two-thirds of the forearm. But it occasionally happens that the anterior cutaneous branch of the musculocutaneous nerve is not reached by the supracondylar injections, because it pierces the deep fascia a little lower than the elbow-joint. After testing the operative field, the injections are repeated just below the elbow, if necessary. When the injections are made at the level of the lower third of the forearm it is necessary to distribute the solution subfascially as well as subcutaneously, so as to reach the palmar cutaneous branches of the ulnar and median nerves.

Synovial cysts of the wrist are excised by infiltrating the tissues around the cyst, care being exercised not to distort the anatomic features of the region. A rhombus is traced on the skin with its greater diameter corresponding to the proposed line of incision and injections are made along its sides through wheals raised at its angles. The deeper layers are injected before the needle is passed in the subcutaneous tissue, and the 0.5 per cent. solution thus distributed evenly around the operative field.

OPERATIONS ON THE HAND

All operations on the hand are painlessly performed by blocking the median and ulnar nerves at the wrist (pages 206 and 212) and infiltrating the "wrist bracelet" (page 316), passing through the sites of puncture of the said nerves, unless pathologic conditions contraindicate injections at that level, in which case they are made at the elbow, or the brachial plexus is block induced. In case of infection of the diffuse phlegmonous type the anesthetic procedures must always be accomplished at the greatest possible distance from the infected region. The brachial plexus block by the supraclavicular route (page 189) is to be resorted to in preference to any of the other procedures.

For operations on the skin of the dorsum of the hand it is sufficient to circuminject the operative field with the 0.5 per cent. solution injected subcutaneously; but for those in the palmar region it is absolutely necessary to block the median and ulnar nerves (pages 206 and 212) and infiltrate the "wrist bracelet," unless the operation involves only the ulnar margin of the hand, in which case the ulnar block at the elbow

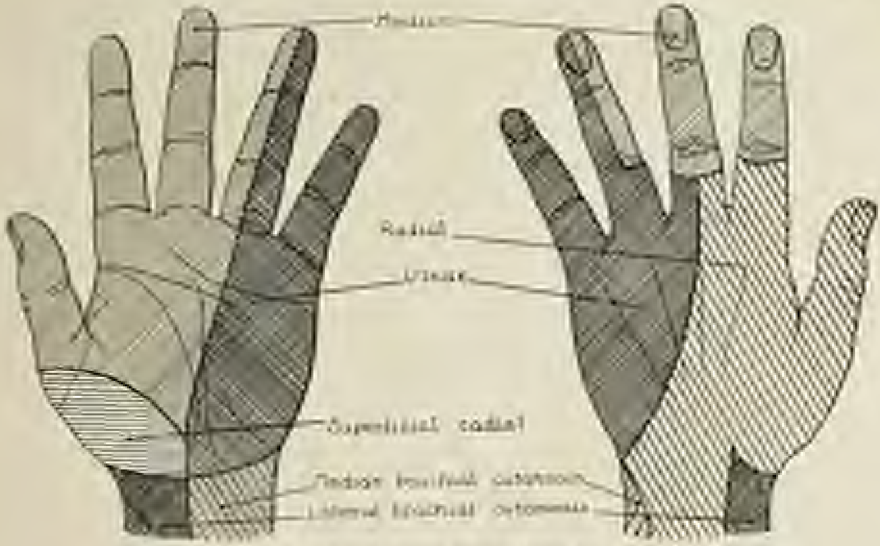

Fig. 243.—Sensory areas of the hand.

Fig. 244.—*Zone of anesthesia resulting from the median and the ulnar block associated with the "wrist bracelet."*

(page 212) is the method of choice. It is not customary to anesthetize the hand by puncturing the skin of its palmar aspect. The injections

are made from the dorsum of the hand, which lends itself better to the passage of the needle than the skin of the palm.

The *fingers* are anesthetized either separately or with their metacarpals, according to the needs of the operation, by local infiltration and field-block. The amputation of the little finger, however, is best performed by the ulnar block at the wrist, or at the elbow (page 212).

Fig. 248.—Manner of injecting the interosseous spaces from the dorsum of the hand. The forefinger of the left hand controls the position of the point of the needle under the skin of the palm.

The *thumb* is anesthetized either alone or with its metacarpal bone. If alone, a subcutaneous ring of infiltration is made at the root of the thumb (Reclus) by passing the needle through two wheals raised one on each side of the first phalynx, very near its dorsal aspect, injecting the solution around the entire circumference of the thumb, in a plane at right angles to its axis. About 5 c.c. of the 1 per cent. solution is sufficient. The edematous ring thus produced is slightly massaged and the operation begun only when the anesthesia has reached the tip of the thumb, which takes about five minutes.

For the *amputation of the thumb with its metacarpal*, which is extremely rare, or for any plastic operation on the thenar eminence, it is preferable to block the median and ulnar nerves at the wrist and infiltrate the "wrist bracelet," that is, anesthetize the whole hand (page

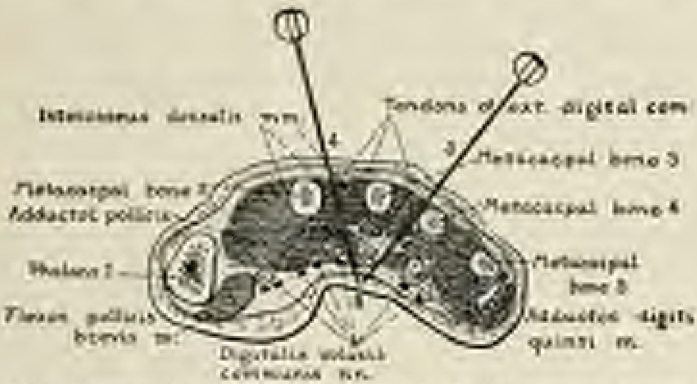

Fig. 246.—Cross-section of the hand through the interosseous spaces, showing direction of needle toward *B* in the palmar region; 3, 4, and *B* correspond to similar points in Fig. 248.

324). But if the operation is not likely to extend beyond the carpometacarpal joint, the following procedure is very satisfactory:

Three wheals are raised on the dorsum of the hand, viz., the first, at the level of the carpometacarpal joint, almost on the radial aspect

Fig. 247.—Manner of injecting the interosseous spaces and palmar region from the interdigital fold.

of the hand; the second, at the upper extremity of the first interosseous space; the third, at the lower extremity of that space at the level of the metacarpophalangeal joint (Fig. 248). The patient's hand is held by

the operator in such a way that one of his fingers may control the position of the point of the needle at any time during the procedure and thus prevent it from piercing the skin of the palmar region. Needle No. 2 (5 cm.), attached to the syringe filled with the 1 per cent. solution, is passed through wheals 5 and 6 in succession and the solution distributed fanwise in the interosseous space, against the metacarpal bone. The needle is then inserted through 5 and 7 and advanced toward *A* in the palm of the hand, and the solution distributed subcutaneously

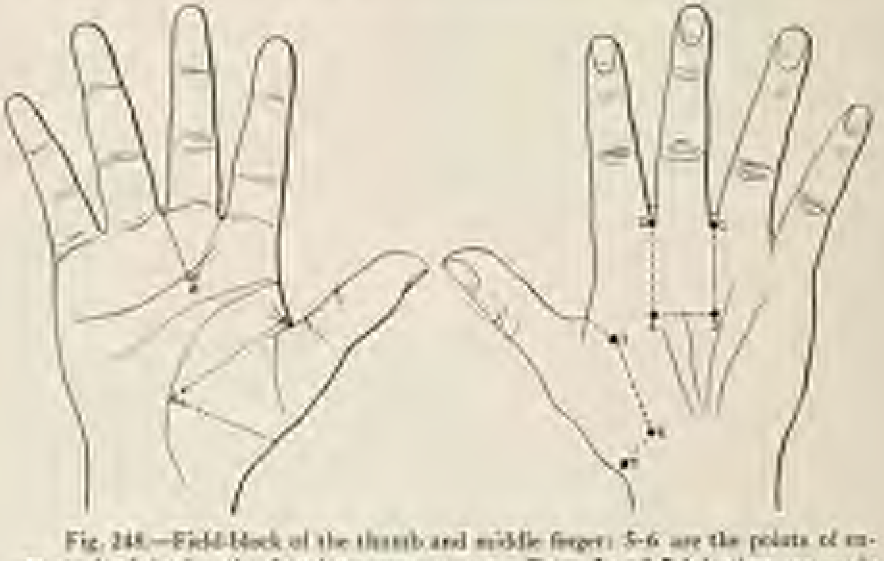

Fig. 248.—Field-block of the thumb and middle finger: 5-6 are the points of entrance for injecting the first interosseous space. From 5 and 7 injections are made toward *A* in the palmar region; 1, 3, 2, 4 are the sites of puncture for the injection of the second and third interosseous spaces. From 1 and 2 injections are made toward *B* in the palmar region. Subcutaneous injections are carried along the dotted lines.

as well as in the deeper structures. The syringe is slowly, steadily, and continuously discharged while the needle is advanced, as well as when it is drawn backward for the purpose of changing its direction. Wheals 5, 6, and 7 are then joined together by a subcutaneous injection if this has not already been done while injecting the interosseous space. The region is finally massaged and the operation begun as soon as the tip of the thumb has become insensitive to the pricks of a needle, which is the usual test for anesthesia. About 20 *c.c.* of the 1 per cent. solution is all that is needed for this procedure.

Fig. 249.—Field-block of a portion of the palm, above the forefinger, from two points of entrance situated on the dorsal aspect of the first and second interdigital folds.

Fig. 250.—Field-block of two fingers for metacarpophalangeal disarticulation.

The *amputation of a finger* is easily performed by making a subcutaneous ring of infiltration around the root of the finger (Reclus), the needle being introduced through two wheals placed one on each side

of the dorsal aspect of the finger at the interdigital folds. If the metacarpal bone or part of it is involved in the operation the interosseous spaces on each side of the bone are infiltrated with the 1 per cent. solution distributed fanwise on their whole length. The needle is passed successively through four wheals raised on the dorsum of the hand, one at each extremity of the adjacent interosseous spaces, and advanced toward the palm, while one of the operator's fingers on which rests the patient's hand controls the position of the needle (Fig. 245). Figure 247 shows the manner of injecting the interosseous space from the

Fig. 251.—Field-block of the fingers and part of the palmar region for operation on the phalanges: From 1 to 4 are the sites of puncture; the dotted lines mark the subcutaneous injections: *A* and *D* are beneath the skin of the palm.

point of entrance at the interdigital fold. The wheals are finally joined together, except 1–2, by subcutaneous injections made with the same solution, using a total quantity of 20 c.c. of the 1 per cent. solution (Fig. 248).

The *amputation of two fingers with their metacarpals* can also be performed by infiltrating the extreme interosseous spaces, as well as the intermediate one, in the manner described for the amputation of one finger, about 5 c.c. more of the solution being necessary. The subcutaneous injections are, as a rule, made last to prevent distortion before the deep injections are completed.

The foregoing examples show that it is possible to anesthetize any limited portion of the hand by distributing the solution in the immediate vicinity of the operative field, or by infiltrating a ring at the root

Fig. 252.—Cross-section at the base of a finger showing the situation of the nerves in the subcutaneous tissue.

of the finger, when the operation is restricted to the segment below the injection. The principles observed in the course of these procedures may be summarized as follows:

Fig. 253.—Field-block of the four fingers and part of the palmar region: 1 and 5 are on the margins of the hand, toward its dorsal aspect.

(a) Intradermal wheals are always raised on the dorsum of the hand, and the needle advanced toward the palmar region by passing

through the interosseous spaces or around the margins of the hand. The palm is never punctured for the purposes of anesthesia.

(*b*) The operator holds the patient's hand with his left hand in such a way that one of his fingers may control the position of the point of the needle beneath the skin of the palm.

(*c*) Small quantities of the 1 per cent. solution are preferred to large quantities of the 0.5 per cent. solution, so as to avoid prolonged anemia

Fig. 254.—Field-block of portions of the dorsal aspect of the hand.

with consequent sloughing. For the ring, 3 c.c. of the 2 per cent. solution are better than 5 c.c. of the 1 per cent. solution.

(*d*) The injected area must be massaged to facilitate the diffusion of the anesthetic fluid.

(*e*) The tip of the finger must be insensitive to painful stimuli before the operation is begun.

(*f*) Infection of the diffuse phlegmonous type contraindicates the use of the local procedures. Nerve-block must be resorted to and induced at the greatest possible distance from the focus of infection.

CHAPTER VIII

OPERATIONS ON THE THORAX

All operations involving the skin and superficial fascia are made by field-blocking, that is, by subcutaneous infiltration around the lesion; for instance, for excision of a lipoma wheals are infiltrated around the tumor and at a little distance from it and subcutaneous injections with the 0.5 per cent. solution made along the lines joining the wheals together. The needle is then passed beneath the tumor and the solution distributed in the depth so as to obtain a more complete anesthesia. If the muscles have to be cut through, paravertebral anesthesia is the method of choice.

THORACOTOMY

If the operation involves only one rib, paravertebral dorsal block (page 214) is made of four thoracic nerves, of which two supply the intercostal spaces immediately above the rib to be resected, and two the spaces below. This procedure is applicable to the case in which the reaction extends to the dorsal portion of the rib in close proximity to the spine. The operative field is then circuminjected with the 0.5 per cent. solution to reduce bleeding to a minimum.

But for the resection of a few centimeters of the lateral or the anterior portion of the rib (Fig. 255), where the overlying soft structures are thin, it is easier to use the following procedure:

Considering the length of the rib to be resected, four (or more) wheals are raised, two in the space above and two in the space below, one at each extremity of the operative field and about 5 cm. beyond its limits. Through each of the posterior wheals needle No. 2 (5 cm.), attached to the syringe filled with the 1 per cent. solution, is introduced and passed under the lower border of the rib in the direction of the intercostal nerve lying in the subcostal groove between the intercostal muscles. The needle must not be introduced more than 0.5 cm. deeper than the posterior surface of the rib, and not more than 2 c.c. of the

solution injected without moving. The direction of the needle is then changed and the intercostal muscles as well as the overlying structures infiltrated with small quantities of the same solution, care being exercised not to inject within the pleural cavity or the lung (page 231). The four wheals are then joined together by subcutaneous infiltration, so as to check the overlapping superficial nerves and control bleeding. Complete anesthesia obtains almost immediately after the last injection.

The same procedure holds good for the resection of *two adjacent ribs* unless the operation extends back of the costal angle to the spine,

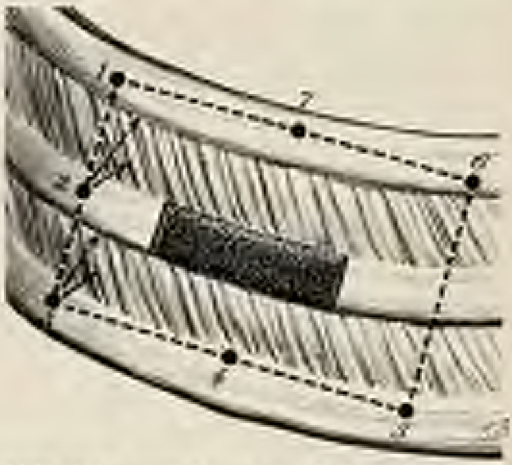

Fig. 255.—Field-block for partial resection of rib. The dark area represents the portion of rib to be resected. The intercostal nerves and spaces are injected through 2 and 3, and subcutaneous injections are made joining the wheals together along the dotted lines through 1-2-3-4-5-6-7-1.

in which case the paravertebral block is the procedure of choice. The thoracic nerves supplying the two ribs and the three adjacent intercostal spaces are injected, supplemented by the injection of one nerve above and one nerve below the extreme intercostal spaces involved in the surgical maneuvers, thus making a total of five injections. Bleeding is minimized by the circuminjection of the operative field with the 0.5 per cent. solution. If the field-block is resorted to for the resection of small portions of two adjacent ribs, either on the lateral or on the anterior aspect of the thorax, wheals are raised at the extremities of the operative field, in the three adjacent intercostal spaces in the middle of

which lie the two ribs, and each intercostal nerve injected as described for the resection of a single rib. For more than two ribs it is better to induce the paravertebral block (page 214), injecting one or two nerves above and one or two nerves below the field involved in the operation, unless the operative area lies on the anterior wall of the thorax (Fig. 256), in which case the field block finds its practical usefulness.

For the *resection of costal cartilages* it is much better to use the field-block procedure than to inject the thoracic nerves at their emergence from the spine. The costal cartilages are far from the spine and are

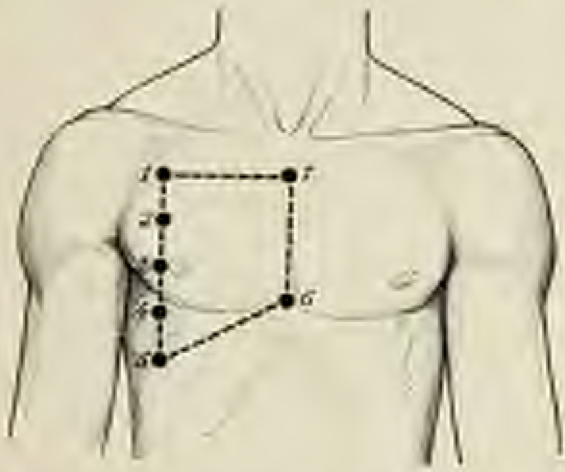

Fig. 256.—Field-block for resection of costal cartilages. The intercostal nerves and spaces are injected through 1 to 5, and the field circuminjected along the dotted lines 1-2-3-4-5-6-7-1.

more easily anesthetized by blocking the intercostal nerves in the neighborhood of the operative field, as is done for rib resections, and making subcutaneous injections along the midline of the sternum, in case of unilateral operation. For bilateral resection the intercostal nerves are blocked on both sides a little beyond the operative area and the midline infiltration is dispensed with.

For *operations on the sternum* it is easier to block the region than to induce a paravertebral block of seven thoracic nerves, which means fourteen injections. Wheals are raised on both sides of the sternum, as illustrated in Fig. 257. Through each of these wheals needle No. 2 (5 cm.)

is inserted perpendicular to the surface of the skin and advanced toward the cartilage or the rib with which it soon comes in contact. It is then inclined upward and gently advanced in the intercostal space, not more than 0.5 cm. deeper than the outer surface of the rib or cartilage, where about 5 c.c. of the 1 per cent. solution are injected fanwise. The needle is then partly withdrawn, passed downward over the cartilage and directed toward the space below, in which 5 c.c. of the same solution are injected. The other spaces are infiltrated in the same manner, and all the wheals are finally joined by subcutaneous injections of the 0.5 per cent. solution.

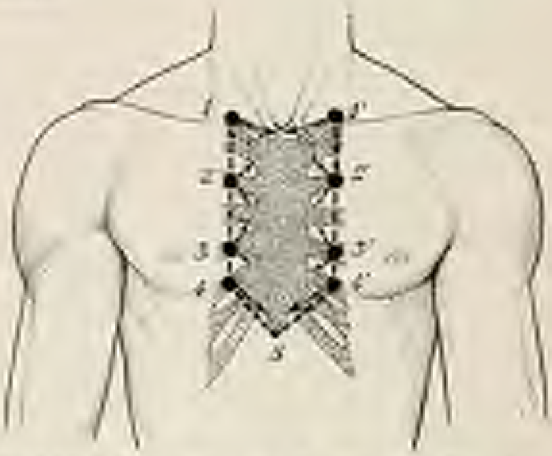

Fig. 257.—Field-block for operations on the sternum. The intercostal spaces are first injected through 2, 3, 4, 4', 3', and 2', and the sternum is circuminjected subcutaneously along the dotted lines.

In cases of chronic osteomyelitis of the costosternal region, exploration of the sinuses before the anesthesia is induced gives an approximate idea of the extent of the field to be blocked. A unilateral sinus in the immediate neighborhood of the sternum prompts the anesthesia of the whole sternum before the operation is begun. A sternal sinus on the midline likewise suggests that the anesthesia be extended to a portion of the ribs on both sides. These precautionary measures eliminate the inconvenience of supplementary injections in the course of the operation.

When operating on the lateral aspect of the thorax it must be remembered that the lateral cutaneous branches given off by the

thoracic nerves pierce the external intercostal muscles between the anterior and posterior axillary lines and immediately divide into anterior and posterior filaments. Subcutaneous injections made along these lines do not reach the points of emergence of the lateral cutaneous branches, but only their terminal filaments. The result is a small zone

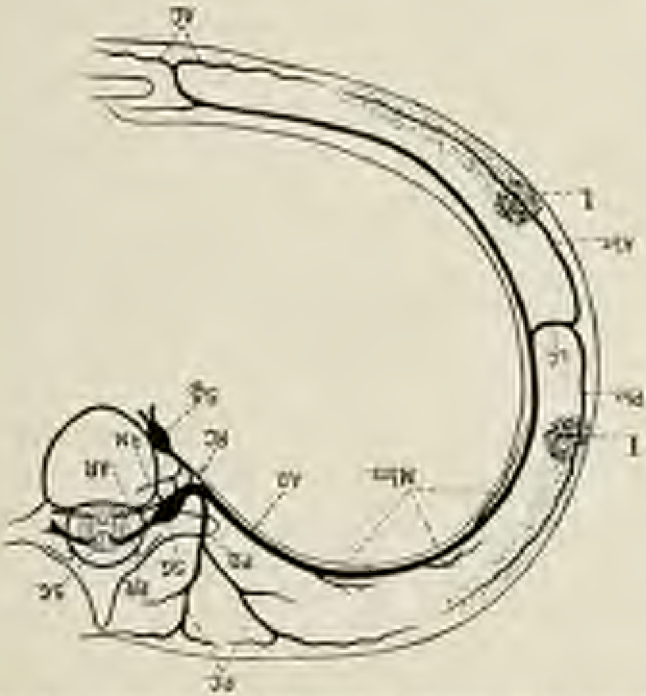

Fig. 258.—The possible result of subcutaneous injections on the lateral aspect of the thorax, which can be avoided by blocking the intercostal nerve in the subcostal groove. (See also Figs. 172 and 173.) *I, I*, are the sites of injection and the light shaded zones indicate the resulting anesthesia.

of cutaneous anesthesia on each side of the lines of injection, thus leaving intact the area within them, which is the operative field (Fig. 258). Paravertebral block, or the injection of the intercostal nerves in the subcostal groove, are the only logical procedures.

The thoracic viscera are insensitive to painful stimuli, provided they are not manipulated at the level of their pedicles.

LAMINECTOMY

Paravertebral injections are made of two nerves above and two nerves below the vertebræ involved in the proposed operation, so as to have a wider field of anesthesia. The injections are made very close to the spine, in order to reach the posterior primary divisions of the thoracic nerves. Needle No. 3 (8 cm.) is passed through as many wheals as are necessary for the proposed anesthesia, and after injecting between the transverse processes of two adjacent vertebræ, according to the technic described on page 222 for the paravertebral block, the solution is distributed fanwise in the overlying paraspinal soft structures, thus creating two walls of anesthesia one on each side of the spine. The wheals are finally joined together by a paramedian line of subcutaneous infiltration. The fanwise injections, as well as the subcutaneous infiltration, reduce to a minimum the hemorrhage otherwise troublesome in the course of the operation.

Care should be exercised while making the fanwise injections close to the spine not to allow the needle to pierce the ligamenta subflava and enter the spinal canal. The puncture of the epidural space has no greater importance than the possibility of a little hemorrhage controllable in the course of the laminectomy; but if the point of the needle reaches the subarachnoid space, the solution is unconsciously injected within it, and toxic symptoms may appear. It is therefore recommended to take contact with the spine each time that the injection is made in the depth and strictly control the direction of the needle which should not make less than 45 degrees with the sagittal plane of the body.

Pain is experienced only when the cord and the posterior roots are approached, provided the solution has diffused to the recurrent branches supplying the cord membranes; otherwise the dura is still sensitive. Manipulation of the dura and the cord may be rendered painless by the injection of a few drops of the 2 per cent. novocain solution within the subarachnoid space, before incising the dura. It is customary to insensitize these structures by applications of thin bands of cotton moistened with the 1 per cent. novocain solution, or with 0.4 per cent. stovain solution (Harris), kept in contact with the dura, then with the cord.

If the operation extends to the upper dorsal region of the spine, a transverse line of subcutaneous infiltration is made at the base of the neck, or between the shoulders, to control the overlapping superficial cervical nerves.

SIMPLE AMPUTATION OF THE BREAST

Simple amputation of the breast is performed by field-block, which has become the routine procedure for that operation in a great many

Fig. 259.—Field-block for simple amputation of the breast. The arrows show the direction of the deep injections beneath the gland.

institutions. A certain number of wheals are raised around the breast and at a little distance from it (Fig. 259), and through these wheals deep injections are made beneath the gland, so as to check the sensory contribution brought in by the upper thoracic nerves approaching the

gland from the pectoralis major muscle. For so doing, the gland is raised and retracted inward by the left hand to facilitate the insertion of the needle beneath it (Fig. 260). If the needle encounters resistance in the depth, it means that it has passed into the gland. It should be removed and reintroduced more backward. The retroglandular tissue offers no resistance to the point of the needle, since it is composed of loose connective tissue. Care should be exercised not to pass the needle

Fig. 260.—Manner of holding the breast while injecting beneath the gland.

between two ribs into the thoracic cavity. It is sufficient to make the injections radially toward the central part of the gland, slowly and steadily discharging the syringe while the needle is advanced as well as while it is withdrawn. Subcutaneous injections are finally made around the gland joining all the wheals together, so as to control the nerve supply coming from the lateral and anterior cutaneous branches of the thoracic nerves and from the supraclavicular branches of the cervical plexus. Weak solutions should always be preferred to strong

ones, the 0.5 per cent. solution being used in varying quantities according to the weight of the patient or size of the gland. It is customary to inject from 125 to 150 c.c. in the average cases of a moderate-sized breast. Light massage helps the diffusion of the anesthetic fluid, and ten minutes are allowed before the operation is begun.

The paravertebral block (page 214) of D^1 to D^6 may also be used as a substitute for the field-block just described. It produces a wider anesthetic area, but needs more experience. It must be supplemented by injections made along the clavicle, so as to cut off the overlapping supraclavicular branches of the cervical plexus.

For the simple amputation of *both breasts* the field-block procedure should be used cautiously, because large quantities of fluid are necessary to complete the anesthesia. The injection of from 300 to 350 c.c. of the 0.5 per cent. solution in both breasts occasionally gives rise to a sudden reaction which may be attributed to the adrenalin solution contained in the anesthetic fluid, when the acceleration of the pulse and heart distress are the predominant symptoms. The reaction is ordinarily benign and of very short duration, clearing up after two or three minutes without actual treatment. But pallor of the face, with cyanosis of the lips, ears, and tips of the fingers, are suggestive of toxic symptoms due to novocain, the more so when a nauseated condition completes the picture. On the other hand, it is possible that the benign reaction due to adrenalin adds itself to the deleterious effects of novocain in certain patients suffering from lesions of the vascular system or a very low-grade exophthalmic goiter, which evidently bear no relationship to the disease which brought them to the surgeon. Absorption seems besides to be very rapid in the mammary gland. It is true that novocain is of very low toxicity, but it must be borne in mind that this is only true when the dose injected is within the limits of safety for the patient under consideration. The use of 500 to 600 c.c. of the 0.5 per cent. novocain solution, as reported by Kappis, does not seem advisable, at least with the drug we have at our disposal, when the injection of 300 to 350 c.c. of that solution is likely to give rise to toxic symptoms in a certain category of patients.

When injecting large quantities of the 0.5 per cent. novocain-

adrenalin solution for the simple amputation of both breasts it is, therefore, recommended to observe the following rules:

(*a*) Careful examination of the circulatory condition of the patient must be made, so as to fix beforehand the quantity of solution to be injected and consequently the dose of adrenalin to be used.

(*b*) Not more than 25 drops of adrenalin should be added to the total amount of solution prepared for injection.

(*c*) Care should be exercised not to distribute the solution in the gland, but beneath it. The injection in the gland serves no purpose. It, however, increases uselessly the dose of novocain.

(*d*) Injection should be slow, thus reducing the velocity of absorption.

(*e*) Weak patients and those suffering from lesions of the vascular system should have the benefit of a preliminary dose of the caffein compound stimulant (page 28) before the anesthesia is begun.

(*f*) If the frequency of the pulse increases, the injection should be stopped for a while and resumed very slowly two or three minutes later.

(*g*) Pallor of the face and cyanosis must be treated by the injection of the caffein compound stimulant if a preliminary dose has not been given. These symptoms appear ordinarily at the end of the anesthetic procedure, during the injection of the other breast, after large quantities of fluid have been thrown into the circulation. If the injections are then stopped and the operation is begun, the excision of the breast first anesthetized, in depriving the organism of the solution injected in the gland, ordinarily relieves the condition. The anesthesia of the other breast may then be completed by supplementary injections.

The foregoing discussion is not meant to discourage the use of field-block for the simple amputation of both breasts, since it is the procedure of choice, as already stated, especially for those who are not familiar with the paravertebral block. But it serves to put the anesthetist on his guard against injecting large doses of novocain-adrenalin solution before examining the condition of the heart and blood-vessels, and to teach him the successful management of all kinds of patients.

For the excision of benign tumors of the breast, such as fibroma, adenoma, cysts, it is customary to circuminject the lesion with the 0.5 per cent. solution, according to the general principles of technic of

regional anesthesia. The tumor is fixed by the left hand, the needle passed through a certain number of wheals raised around it (Fig. 261), and the solution distributed fanwise in the substance of the gland in the immediate neighborhood of the tumor. Subcutaneous injections are then made along the lines joining the wheals together, thus avoiding the injection along the line of incision. From 40 to 50 c.c. of the 0.5 per cent. solution are sufficient to produce absolute anesthesia. The gland is lightly massaged to help the diffusion of the injected fluid.

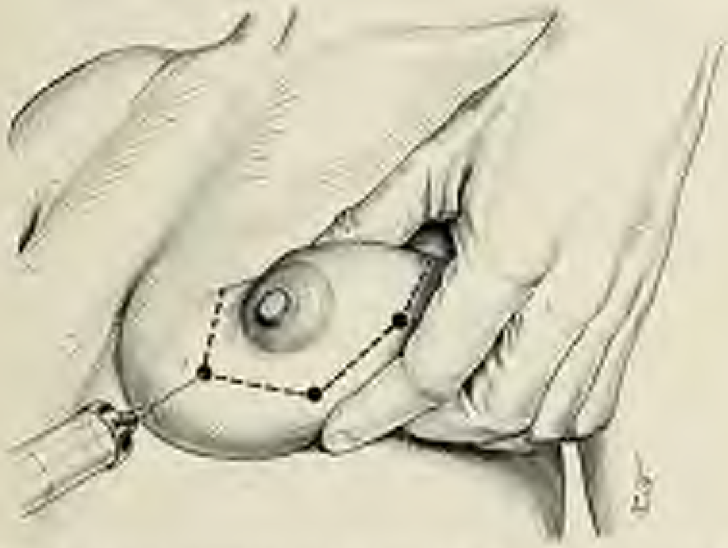

Fig. 261.—Field-block for excision of a fibroma of the breast. (Partly after Braun.)

For the esthetic removal of multiple adenomata or cysts, or for the excision of part of the gland by way of the axillary incision, or the crescentic sulcus incision, the procedure described for the simple amputation of the breast is the one of choice (Fig. 259). The injection along the line of incision should be avoided, because it is occasionally followed by a defective healing of the wound which results in an ugly scar.

RADICAL AMPUTATION OF THE BREAST

Complete control of the psychic element of the patient must be obtained before the anesthetic procedure is begun. The usual dose

of morphin ($\frac{1}{4}$ gr.) and scopolamin ($\frac{1}{150}$ gr.), given one hour before, is supplemented by a second injection, especially in fat women, either at the beginning of the injections or as soon as they have been completed, according to the nervous behavior of the patient. But, by all means, the mentality of the patient must be dulled at the time of the operation, two doses of the combined narcotics being always sufficient to produce the desired result (page 12) without inducing a state of mental confusion.

After blocking the brachial plexus by the supraclavicular route (page 189) paravertebral injections are made from D^1 to D^{10} according to the procedure described on page 214, and the anesthesia completed by subcutaneous injections of the 0.5 per cent. solution made along the acromion and clavicle, coursing down the midline of the sternum and linea alba as far as the umbilicus. A very wide anesthetic field is thus obtained comprising the hemithorax and upper abdominal wall and the axilla, permitting of the most extensive operation. The subcutaneous infiltration along the acromion and clavicle serves to control the supraclavicular branches of the cervical plexus; that made along the midline of the sternum and abdominal wall checks the overlapping nerve filaments coming from the opposite side. Bleeding is not much reduced by this procedure; but it can be controlled by the application of large sponges moistened with hot saline solution which are removed after the excision of the gland and dissection of the axilla. If the skin is dissected beyond the midline, the subcutaneous infiltration along the sternum will be displaced outward on its margin and continued downward on the abdominal wall. From 125 to 150 c.c. of the 0.5 per cent. solution are sufficient for the subcutaneous injections.

In lean patients the following procedure gives very satisfactory results: After inducing the brachial plexus block by the supraclavicular route (page 189), subcutaneous injections are made around the operative field, along a line starting from the acromion, passing along the clavicle, turning downward on the midline of the sternum as far as the xiphisternum, then outward and downward along the costal margin up to the tip of the eleventh rib, and finally running vertically upward toward the axilla, which it meets at the level of the latissimus dorsi

muscle (Fig. 262). The injections are made through as many wheals as are necessary to complete the course just described. Before making the subcutaneous injections on the side of the trunk, along the axillary line, wheals are raised over every other rib and the intercostal nerves blocked at that level. Needle No. 3 (8 cm.), which is the size ordi-

Fig. 262.—Regional block for radical amputation of the breast: *B*, Brachial plexus block; 4', 5, 6, 7, 8, blocking of the intercostal nerves; 8, infiltration of the axilla; 1-2-3-4-4'-5-6-7-8, subcutaneous infiltration.

narily used for the subcutaneous injections, is passed through each of the wheals in succession and advanced toward the rib in a direction perpendicular to the surface of the skin. After taking contact with the rib, the skin is moved downward a little, so that the point of the needle may reach the lower border of that rib while its shaft is slightly inclined

upward. The needle is then passed under the lower border of the rib and advanced 0.5 cm. further in the subcostal groove, where injection is made of from 2 to 3 c.c. of the 1 per cent. solution without moving, always taking care not to inject within the pleural cavity or the lung. After blocking the nerve corresponding to the wheal, the needle is partially withdrawn and advanced upward, in the subcutaneous tissue, toward the lower border of the rib above, on which it impinges gently. Helped by the tip of the left forefinger, which controls all the time the position of the point of the needle as it is advanced in the subcutaneous tissue, the needle is passed below the rib into the subcostal groove, where a similar injection is made. One point of entrance thus serves for the injection of two nerves.

The injection of the second and third thoracic nerves is rather difficult by this procedure. Needle No. 4 (10 cm.) is passed through the uppermost wheal raised on the lower border of the latissimus dorsi muscle and advanced in the axilla toward the third, then the second rib, and after taking contact with each of them, 3 c.c. of the 1 per cent. solution are injected in the intercostal muscles below them. The 0.5 per cent. solution is finally distributed fanwise over the thoracic wall of the axilla, so as to reach the intercostohumeral nerves given off by the intercostal nerves to the brachial plexus, using 30 c.c. of the said solution. The injections are made slowly, steadily, and continuously while the needle is advanced as well as when it is withdrawn. The dose of novocain injected by this procedure is as follows: 20 c.c. of the 2 per cent. solution for the brachial plexus block (0.40 gm.), 30 c.c. of the 1 per cent. solution for the intercostal block (0.30 gm.), and from 150 to 200 c.c. of the 0.5 per cent. solution for the subcutaneous infiltration (0.75 to 1 gm.), making a total of from 1.45 to 1.70 gm.

The total dose of adrenalin solution (1 : 1000) must not exceed 30 drops, distributed as follows: 4 drops in the 2 per cent. solution, 6 drops in the 1 per cent. solution, and 20 drops in the 0.5 per cent. solution.

In this procedure the blocking of the intercostal nerves on the side of the trunk is a substitute for the paravertebral block. The injections are more easily and quickly done in the average patients of moderate

weight. The first procedure is preferable when palpation of the ribs along the axillary lines is rendered difficult by the thickness of the overlying soft structures. With increasing experience, the intercostal block in fat patients will be found easier and more reliable than the paravertebral block, since the difficulty in inducing the latter increases with the weight of the patient, especially when the upper thoracic nerves are concerned.

CHAPTER IX

OPERATIONS ON THE ABDOMEN

OPERATIONS on the abdomen are divided into two groups, viz., those in which the operative maneuvers involve chiefly the abdominal wall; those in which the chief surgical act aims at the abdominal organs, laparotomy being simply a means of approaching the diseased viscus. The first includes tumors of the abdominal wall and hernias (umbilical, epigastric, hypogastric, inguinal, and all postoperative ventral hernias), for which the field-block is the procedure of choice. In the second group of operations the opening of the abdominal cavity may be performed by the field-block of the abdominal wall or by the paravertebral block. If the field-block is selected, the abdominal cavity and its contents, or at least the region of the diseased viscus, is anesthetized by special procedures, resulting in what is termed "splanchnic analgesia." If the paravertebral block is resorted to, the result is the anesthesia of a segment of the trunk offering opportunities for the completion of the operation without the use of supplementary injections. Before describing the procedures used for each abdominal operation it is of real importance to discuss briefly the sensibility of the abdomen.

Individual Sensibility to Pain.—The expression of pain is not proportional to the intensity of the stimuli. It varies with the individual and is influenced by a great number of circumstances, among which the psychology of the patient holds a preponderant place. Age, sex, race, character, education, intelligence, occupation, and the nature of the disease are factors which tend to modify individual sensibility to pain. Apprehension increases the ability to react to painful stimuli; diversion reduces it to a minimum. Pain sense is but slightly developed in the newborn child; adolescents in the prime of life are less tolerant than old people. Women are more sensitive than men. People of the North seem to be more enduring than those of the South; city-bred more sensitive than country people. Strong-minded, educated, and

intelligent persons give an outward expression of only part of the pain they actually feel, while the weaker, uneducated, and less intelligent very often exhibit violent reactions which are out of proportion to the painful stimuli induced. Workmen, laborers, farmers, and all those who are used to daily contact with rough surfaces and heavy tools, or who are exposed to repeated injuries by the nature of their occupation, are less sensitive than those whose occupation is not burdened with such hardships. Certain pathologic conditions often determine troubles of the general sensibility, either by exalting the psychic element of the patient to the stage of hyperesthesia, or by dulling his perception of painful stimuli to the degree of hypesthesia. Acute inflammatory diseases, in exaggerating local pain, render the patient more excitable; chronic, cachectic diseases, on the contrary, reduce the susceptibility to pain by effecting in the nervous system nutritive changes which either blunt perception or hinder the transmission of peripheral stimuli to the brain. The ability to react is also greatly reduced. Morphin and scopolamin, administered in judicious doses, modify the degree of sensibility to pain and establish favorable conditions for the necessary manipulations of the anesthetic procedure, as well as for the surgical treatment of the disease. With the combined narcotics it is possible to equalize the different individual expressions of pain and bring them down to the lowest convenient term.

Sensibility of the Abdominal Wall.—The skin of the abdominal wall is occasionally very sensitive to the pricks of the fine intradermal wheal needle in all categories of patients, without its being possible to determine to what particular group these patients belong. Neurotics are always more sensitive than the others. Acute conditions of the abdomen in their earlier stages are attended by greater tenderness of the skin which in certain cases cannot be grazed by the finger. In the latter period of the disease there is a marked absence of reaction to painful stimuli, due to the decreased vitality of the central nervous system. Skin reflexes in acute abdominal diseases are well known. The superficial fascia is not sensitive, although it contains all the nerves which are destined for the skin and the deeper structures. No pain is felt when the needle is passed through the wheal into the superficial fascia

and advanced in all directions parallel with the skin, unless the point of the needle happens to hit one of the nerves. A patient never complains of subcutaneous injections, but as soon as the point of the needle comes in contact with the deep fascia pain is, as a rule, experienced, and the reaction of the patient is, in practice, used as a signal to denote that the deep fascia has been approached. The rectus sheath seems to be more sensitive than the rest of the deep fascia of the abdominal wall. It should, therefore, be pierced rapidly by a sudden and sharp thrust as soon as it has been approached. The needle can be advanced in the recti muscles with very little discomfort to the patient. It is only when the point of the needle passes in the sensory nerve regions, between the bundles of the muscle-fibers, that light pain is felt. When the point of the needle reaches the posterior wall of the rectus sheath, or is in its immediate vicinity, there is ordinarily some pain, due probably to the approach of the intercostal nerves crossing the posterior aspect of the muscle on their way to the linea alba. The numerous nerve filaments given off at that level to the retroperitoneal tissue are also responsible for such pain. In the lateral regions of the abdominal wall the deep fascia seems to be less sensitive than in the region of the recti muscles; but the approach of the deep fascia by the point of the needle is always signalled by the patient, and serves as guide for the further advance of the needle within the deeper structures. No distinct sensation is felt when the point of the needle passes through each of the three muscles constituting the lateral musculature of the abdominal wall (external oblique, internal oblique, and transversalis), but pain is felt as soon as the point of the needle reaches the retroperitoneal tissue.

Sensibility of the Abdominal Cavity.—The sensory nerve supply of the abdominal cavity and the organs contained in it has given rise to great controversies. In 1913 Kappis conducted extensive experiments on dogs with a view to throwing some light on the existing conflict of opinion. Excluding the use of narcotics, he tried to determine what pain it would be possible to induce by irritating the intestines. His experiments were divided into two parts, the first consisting of a simple preliminary operation, the second, an examining operation. Sections

of the cord were made at different heights, sections of the abdominal wall along the costal margin, and the results of his experiments were the following: After sectioning the cord between the fifth and sixth dorsal vertebræ there was no pain in the abdomen. After sectioning the cord between the seventh dorsal and eighth dorsal vertebræ there was no pain in the lower abdomen up to the middle of the small intestine, but the stomach, spleen, and upper part of the small intestine were found sensitive. Between the thirteenth dorsal and first lumbar vertebræ (the dog has thirteen dorsal vertebræ) sensibility stopped at the cecum. Kappis concluded, therefore, that below the cecum all organs are supplied by the lumbar and sacral nerves. This is confirmed by the author's clinical experience that the blocking of the three last lumbar nerves and the five sacral nerves gives a complete anesthesia of the pelvis and its contents.

The sectioning of the splanchnic nerves gave an anesthesia of the stomach, spleen, and upper part of the small intestine. The liver seems to bear an embryologic relationship to the gastro-intestinal tract. The kidney was not deprived of sensibility after sectioning the splanchnics, which proved that at least part of its sensibility originates from the lumbar spine. In 1919 Kappis published another very interesting contribution, which adds to the knowledge obtained from his papers of 1913, that the three first lumbar nerves send rami communicantes to the retroperitoneal ganglion, and therefore take part in the transmission of pain from the upper abdominal organs below the sigmoid colon, whose sensory innervation ends with the third lumbar nerve. The sensory innervation goes through the hypogastric plexus to the rectum and to the urogenital apparatus.

Hoffman's clinical findings published in 1920 confirm to a certain extent Kappis' experiments, proving that sectioning of the spinal nerves supplying the abdominal wall is not followed by an exclusion of painful impulses which are always present in the mesentery. He also found that the sectioning of the splanchnic nerves abolishes pain, and is of the opinion that these findings can be applied to man. Hoffman goes still further in contending that there is no difference in pain sensation between the cerebrospinal and vegetative nerve systems, which is

contrary to the opinion of Lennander, who holds that no sympathetic fibers are able to transmit pain. Hoffman says that both systems have the same centripetal tracts; that they transfer the same conscious sensibility and that they have a unit embryologic history; that the sensory nerves lie in the parietal peritoneum, mesentery, and lesser omentum, and that these organs are the starting-point of abdominal pain. He made sections of the peritoneum and used the method of Bielschowski modified by Schultz and Gross, in which nerves are tinted black and easily seen. Vessels are sometimes stained by this procedure, but good pictures of nerve ramifications are usually obtained by which it is easy to distinguish the nerves from the blood-vessels. Sensory nerve-fibers were found to accompany the vessels of the mesentery and also those of the parietal and visceral peritoneum. Certain regions between two vessels contained no nerves. Clamping two adjacent vessels of the mesentery produced pain, and in treating this region by the above process it was found that the clamped vessels contained nerves coming from the splanchnic or sympathetic chain. Dissections also showed that the splanchnic nerves had fibers running to these clamps.

Kappis does not deny the presence of nerve plexuses supplying the viscera and containing sensory nerve-fibers, especially pain-conducting fibers. Their number is relatively small considering the extent of the viscera supplied, and for this reason they lose their ability to transmit painful impulses in the proximate vicinity of the organ itself. It may be that these fibers do not reach the organ with the other nerves, but end at a certain distance from it; it may also be that they do not reach the organ in such number and size as to permit of impulses being interpreted as pain.

Clinical observations in the course of abdominal operations show that the visceral peritoneum is insensitive to all kinds of stimuli. The parietal peritoneum, especially the retroperitoneal tissue, is very sensitive, but it is difficult, if at all possible, to determine which of the two structures is the starting-point of pain, since one cannot touch the parietal peritoneum without interfering with its subserous layer, composed of loose connective tissue, rich in cerebrospinal nerves. Manipu-

lations of the parietal peritoneum result in the cleavage of the retroperitoneal tissue, with consequent elongation or destruction of the nerve plexuses it contains. It is also hardly possible to test the sensibility of the peritoneum lining the posterior wall of the abdominal cavity without interfering with the organs lying in front of it, thus creating other painful disturbances prior to its approach. On raising the viscera or moving them aside, even with the utmost gentleness, tractions are exerted on their pedicles or attachments to the posterior wall of the abdomen; and since the visceral peritoneum is but the continuation of the parietal peritoneum, these tractions are referred to the parietal peritoneum which slides on the retroperitoneal tissue, tearing through the nerve plexuses of this layer.

The abdominal organs are not sensitive. They can be cut through, clamped, bruised, or cauterized without the patient's knowledge, but they cannot be moved about without causing pain.

The greater omentum is insensitive, although the contention is that its attachments to the stomach carry sensory nerve-fibers to the splanchnic nerves and cannot be clamped without pain. The lesser omentum can hardly be manipulated without interfering with the neighboring regions; likewise the base of the mesentery.

Whether or not the splanchnic nerves are the sole or the chief paths of conduction of the painful impulses due to traction on the abdominal organs, the knowledge derived from these experiments is of real practical value, since it has made it possible to simplify the anesthetic procedure used for operations on the upper abdomen especially.

SPLANCHNIC ANALGESIA

The term "splanchnic analgesia" not only applies to the blocking of the splanchnic nerves, but is the modified condition of abdominal sensation resulting from an infiltration of the retroperitoneal tissue in the immediate vicinity of the solar plexus (abdominal brain of Bichat) and permitting of the gentle manipulation of the abdominal organs, especially those contained in the upper abdomen (stomach, spleen, liver, gall-bladder, transverse colon, and small intestine).

As far as experiments on animals are concerned, it has been estab-

lished that the parietal peritoneum is supplied by the thoracic and upper lumbar nerves; but the stomach, small intestine, transverse colon, greater and lesser omentum, liver, and spleen are under the control of the splanchnic nerves, at least partly, which carry painful impulses through the cord to the brain.

The *great splanchnic nerve* is formed by the union of four or five roots arising from those of the middle thoracic sympathetic ganglia which receive contributions from the fifth or sixth to the ninth or tenth thoracic nerve by way of rami communicantes whose number varies greatly. The trunk, thus formed ordinarily on the lateral aspect of the eleventh dorsal vertebra, passes obliquely downward from the thorax into the abdominal cavity by piercing the crus of the diaphragm. It enters the corresponding semilunar ganglion at its lateral angle.

The *small splanchnic nerve* arises from the lower thoracic ganglia of the sympathetic cord connected with the tenth, eleventh, and twelfth dorsal nerves, sometimes with the eleventh and twelfth only, pierces the crus of the diaphragm either with or lateral to the great splanchnic nerve, passes into the abdominal cavity, and distributes fibers to the corresponding semilunar ganglion and renal plexus and to the celiac plexus.

The *semilunar ganglia* are two in number and are situated almost symmetrically one on each side of the midline between the suprarenal bodies immediately above the pancreas, *i. e.*, at the level of the first lumbar vertebra. They are flattened against the crura of the diaphragm and partly covered by the vena cava on the right and the pancreas on the left. They are connected with each other and with their satellite ganglia (celiac, aorticorenal, superior mesenteric) by a thick network of nerve cords which constitute, in front of the aorta and around the roots of the celiac axis and superior mesenteric artery, the *solar plexus*, from which are given off the gastric, phrenic, hepatic, splenic, suprarenal, renal, spermatic, ovarian, aortic, and mesenteric plexuses, as well as the lower plexuses (hypogastric and pelvic). Numerous fibers originate from these plexuses, creep along the arteries, around which they form a network, and accompany these vessels to their respective organs.

Four procedures have been devised for injecting the splanchnic

Fig. 363.—The solar plexus.

nerves, viz., two by the anterior route and two by the posterior route. By the anterior route the injections can be made after laparotomy

(Braun, Pauchet), or before laparotomy (Wendling); by the posterior route they are made either below the diaphragm (Kappis, Naegeli, Labat) or above its attachment to the vertebral column (Marc Roussiel).

Anterior Route.—1. Braun injects the splanchnic nerves after exposure of the stomach and lesser omentum, that is to say, after laparotomy. The abdominal wall is anesthetized by distributing the 0.5 per cent. solution along the costal margin and lateral margin of the recti muscles (page 363). A midline incision is made, and, after retracting upward the left lobe of the liver, the stomach is pushed slightly toward the left and the hand is passed into the abdominal cavity. Medially to the lesser curvature of the stomach the forefinger takes contact with the anterior surface of the first lumbar vertebra. The pulsating aorta is slightly retracted laterally by the finger, thus disclosing the lateral part of the anterior aspect of the vertebra. Needle No. 5 (12 cm.) is then introduced in close contact with the bone and 50 c.c. of the 0.5 per cent. solution of novocain-suprarenin are injected without displacing the needle. In like manner, the right lateral part of the anterior surface of the body of the vertebra is defined and the needle reintroduced, always keeping close contact with that side of the body of the vertebra, and 50 c.c. of the same solution again injected. Braun sometimes makes only one injection on the midline over the body of the first lumbar vertebra. Pauchet anesthetizes the abdominal wall with 1 per cent. solution, and after laparotomy retracts the left lobe of the liver upward and defines the upper margin of the pancreas and the pulsating aorta. To the right of the artery and immediately above the pancreas from 20 to 40 c.c. of 1 per cent. novocain-adrenalin solution is injected. The solution diffuses rapidly to the splanchnic nerves and the semilunar ganglia and soaks at the same time the celiac and mesenteric plexuses.

2. Wendling's technic reported in 1917 is the following: After infiltrating the abdominal wall along the costal margin for the purpose of laparotomy, a long needle is introduced through the abdominal wall, 1 cm. below and 0.5 cm. to the left of the tip of the ensiform cartilage, in a direction perpendicular to the surface of the skin. The needle passes

through the left lobe of the liver and the lesser omentum and reaches the anterior surface of the vertebral column at a depth of about 6 cm., where injection is made of from 50 to 80 c.c. of 1 per cent. novocain-suprarenin solution. The needle must be from 6 to 9 cm. long, have a rather blunt and short bevel, and be of small gage (0.6 mm. thick). The author has never used this procedure, but those who have tried it on the cadaver do not think that it can be safely used as a routine procedure. It is, indeed, so much easier and safer to use Braun's or Pauchet's procedure after exposure of the dangerous zone.

Posterior Route.—1. *Kappis' Technic.*—With the patient lying in the lateral position, back arched and avoiding distortion of the spine, the twelfth rib is defined by palpation and a wheal raised on the lower border of the twelfth rib, 7 cm. distant from the midline of the spine. Needle No. 5 (12 cm.) is introduced through the wheal and advanced toward the twelfth rib, with which it soon comes in contact. The needle is then passed below the rib and inclined toward the spine in a direction making an angle of 30 degrees with the sagittal plane of the body. The point of the needle reaches the vertebral column at the junction of the lateral and anterior aspects of the body of the vertebra, close to the splanchnic nerves. Injection is there made of from 20 to 30 c.c. of a 1 per cent. novocain-suprarenin solution in lean patients, especially women, and from 30 to 40 c.c. in fat patients and men. Two other injections are made through two points of puncture at the level of the first and second lumbar vertebræ, from 15 to 20 c.c. being injected in the depth. The opposite side is anesthetized in the same manner.

Kappis has recently slightly modified his technic, and reduced the number of punctures. A single point of entrance is used, viz., the one already mentioned on the lower border of the twelfth rib; and, after injecting 20 c.c. of a 0.5 novocain-suprarenin solution at the level of the first lumbar vertebra, the needle is introduced in an upward direction to a point 3 cm. above the site of the first injection, where 20 c.c. of the same solution are deposited. The needle is then partially withdrawn and reintroduced downward to reach a point 2 cm. lower than the site of the first injection, where 10 c.c. of the same solution are again deposited. The solution is thus distributed along the vertebral column

from the exit of the splanchnic nerves through the diaphragm to the level of the third lumbar nerve.

Author's Technic.—With the patient lying on either side, back arched, knees flexed and drawn up toward the face, the twelfth rib and the first lumbar spine are defined by palpation. A cushion is slipped under the loin, if the spine is too much bent sideways: the relaxation of the mus-

Fig. 264.—Splanchnic analgesia. Position of patient. The point just under the twelfth rib marks the site of puncture, and the cross, vertically under, is the spinous process of the first lumbar vertebra. The distance between the two is 4 finger-breadths or 7 cm.

cles thereby obtained renders the landmarks more accessible and makes the subsequent steps of the technic easier (Fig. 264). A wheal is raised on the lower border of the twelfth rib, 4 fingerbreadths or 7 cm. distant from the midline of the back. This point ordinarily faces the first lumbar spine. Needle No. 5 (12 cm.), unattached to the syringe, is introduced through the wheal along the horizontal plane of the body,

i. e., vertically to the table on which the patient is resting, and advanced forward and inward in a direction making an angle of about 45 degrees with the median plane of the body. Its point then strikes the body of the first lumbar vertebra near its anterior convexity, in front of the intervertebral foramen,[1] behind the splanchnic nerves, just where these join the semilunar ganglion. When the needle, introduced for about 9 cm., has struck the bone, it is drawn back until its point lies in the

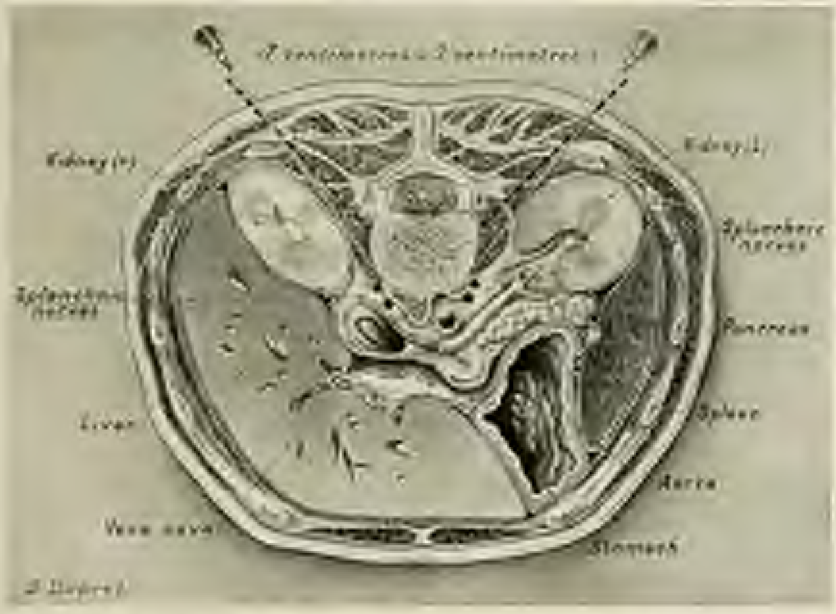

Fig. 265.—Cross-section through the first lumbar vertebra, showing the method of inducing splanchnic analgesia. The needle has been inserted on the lower border of the twelfth rib, 7 cm. distant from the midline of the back. The dotted line marks the direction of the needle introduced toward the spine at an angle of 45 degrees with the median plane of the body. Note its point of contact with the vertebra: the needle is here in its last and good direction: tangent to the body of the vertebra.

subcutaneous tissue (so as to be able to change its direction), and reintroduced at a smaller angle. If its direction is good, the needle passes

[1] The anteroposterior diameter of the first lumbar vertebra measures about 7 cm. in the adult. The distance between the posterior extremity of that diameter and the point of introduction of the needle measures also 7 cm. These represent the sides of a right-angled triangle; and the needle, having been introduced at an angle of 45 degrees, lies along the hypotenuse of that triangle, no allowance being made for the thickness of the soft structures covering the spine.

tangentially to the body of the vertebra; if not, it either impinges on the vertebra at a point nearer its anterior convexity or does not encounter the bone. In the first case, it is again partially withdrawn and reintroduced at a still smaller angle, so that it may reach its correct position. But if no bony resistance is felt after 9 cm. of the shaft of the needle have disappeared in the soft structures of the back, the needle must not be advanced any further, but restored to its original direction in which contact is again taken with the body of the vertebra and other attempts made to reach the anterior aspect of the bone. As soon as the point of the needle is felt gliding along the surface of the vertebra, it is pushed in *1 cm. further*, and, after making sure that no blood comes out of the needle, the syringe is gently connected with it and injection made of 25 to 35 c.c. of the 1 per cent. solution, without displacing the needle. The injection must be slow and the aspiration test made and renewed several times during the injection.

The needle is then partially withdrawn and reintroduced downward toward the body of the second lumbar vertebra, where 20 c.c. of the same solution are injected as soon as the needle passes tangentially to the bone.[1] The patient is then asked to change side and the injections are repeated on the opposite side. The solution spreads easily into the loose retroperitoneal tissue, diffusing in all directions, reaching the solar plexus and its immediate tributary, as well as the cerebrospinal nerve plexuses of the subserous layer, thus anesthetizing a wide area in which all operative maneuvers become painless.

Naegeli uses the same site of puncture on the lower border of the twelfth rib, 7 cm. distant from the midline of the back, and injects from 25 to 35 c.c. of the 1 per cent. novocain-suprarenin solution at the level of the first lumbar vertebra, at the union of its lateral and anterior aspects.

2. Marc Roussiel claims that the splanchnic nerves are anesthetized by paravertebral injections at the level of D^{11} and D^{12} or D^{10} and D^{12}, made in the manner described for the paravertebral block, using 10 c.c.

[1] This second injection is a recent addition to the author's first technic (Gazette des Hôpitaux, Paris, 1920, May, 662, and the British Journal of Surgery, vol. viii, No. 31, 1921).

of the 1 per cent. novocain-adrenalin solution at each site of puncture; and that all operations on the stomach can be painlessly performed by this simple procedure associated with the infiltration of the abdominal wall. The edema thus produced surrounds the splanchnic nerves and spreads in the subpleural tissue, diffusing toward the rami communicantes given off by the eighth and ninth thoracic nerves.

Practical Considerations.—Of the two routes of approach, the posterior is easier and safer, and has a higher practical value than the anterior route: the anesthesia can be completed before the operation is begun; and, if the needle is kept in close contact with the body of the vertebra and never introduced more than 1 cm. further than the point at which it is felt gliding along the lateral convexity of the vertebra, there is no risk of puncturing the aorta, the vena cava, or the renal vessels.

The anterior route of Braun and Pauchet is safer than that of Wendling, because the injection is made under the control of the eye and finger, after retraction of the organs that stand in the way of the needle; but it can only be used with advantage after a midline incision, and in the absence of such pathologic conditions of the stomach, liver, and gall-bladder as would not permit of the free exposure of the lesser omentum. A distended stomach stands too much in the way; so does a stomach adherent to the pancreas or to the liver, *a fortiori*, to both organs. These procedures are, besides, very difficult in certain cases. In stout individuals with tense rigid abdominal walls, as soon as the abdomen is opened, the contents bulge out, and even the packing back is not an easy task. In thin relaxed patients it is usually possible, when much gentleness is used, to slip in two fingers, thus opening the way for the needle to the solar plexus or to the retroperitoneal tissue in its vicinity, care being exercised in the neighborhood of the large vessels. Even under the best conditions the technic is only possible in the hands of those who have acquired sufficient experience of the local methods within the abdominal cavity.

It is unnecessary to discuss the procedure advocated by Marc Roussiel. Those who are familiar with the paravertebral block in abdominal surgery may try it for a gastro-enterostomy (page 368).

In conclusion, the posterior route of Kappis seems to fulfil the best conditions and should be given preference, no matter which technic is used, Kappis', Nargeli's, or the author's; but it is still too early to conclude that this procedure will in the future be used as a substitute for the paravertebral block for operations on the organs of the upper abdominal cavity. Splanchnic analgesia is, however, an important addition to the regional method.

OPERATIONS

LAPAROTOMY

For a high laparotomy two procedures are available, viz., the abdominal field-block and the paravertebral block.

Abdominal Field-block.—With the patient lying in the supine position, wheals are raised along the costal margin and the lateral margin of the recti muscles: one at the tip of the xiphisternum; one on each side, at the level of the tenth costal cartilage, where the lateral margin of the rectus muscle crosses the costal margin; the last two, one on each side, on the lateral margin of the rectus muscle, a little higher than the umbilicus (Fig. 266). For the sake of convenience more than two wheals may be raised on the lateral margin of the rectus, especially in very fat patients. Needle No. 3 (8 cm.) or No. 4 (10 cm.), according to the weight of the patient, is attached to the syringe filled with the 0.5 per cent. solution and passed through each of these wheals in succession. After piercing the skin through one of the lowest wheals the needle is gently advanced in the superficial fascia in a direction *slightly* inclined inward toward the rectus muscle. As soon as the needle touches the rectus sheath, it is quickly pushed in from 0.5 to 1 cm. further and about 2 c.c. of the solution are injected without moving. The needle is then drawn back until its point reaches the subcutaneous tissue, and reintroduced several times more and more obliquely upward, then downward, each time injecting a small quantity of the solution within the rectus sheath. The needle is withdrawn and passed through the other wheals and the solution distributed fanwise higher up and in the muscle layer along the costal margin. When the deep injections have been completed, the solution is distributed subcutaneously along the lines, joining all

the wheals together except the two last, and the region lightly massaged to spread the solution within the tissues. Not more than 100 c.c. of the 0.5 per cent. solution are necessary for an abdominal field block in lean patients; 150 c.c. in very fat persons.

Fig. 266.—Abdominal field-block. Through each wheal (1 to 5) the needle is inserted and advanced within the rectus sheath, where the solution is distributed fanwise, and finally passed into the subcutaneous tissue, where infiltration is made along the dotted lines.

The rectus sheath offers to the point of the needle a resistance which must be felt before advancing the needle any further. Its contact is, besides, always signalled by the patient as a sharp prick (page 350).

The operation may be begun immediately after the last injection, but it is preferable to wait five minutes, so as to avail oneself of the complete relaxation of the recti muscles, which is one of the chief advantages of the procedure just described.

The abdominal field-block thus induced is good for median as well as for paramedian incisions. It can be prolonged downward, according to the particular needs of the operation. The same principles are observed for the induction of a field block for low laparotomy; the solution is always distributed within the rectus sheath, at the level of its lateral margin, so as to block the intercostal nerves before the filaments destined for the rectus muscle are given off (Fig. 267).

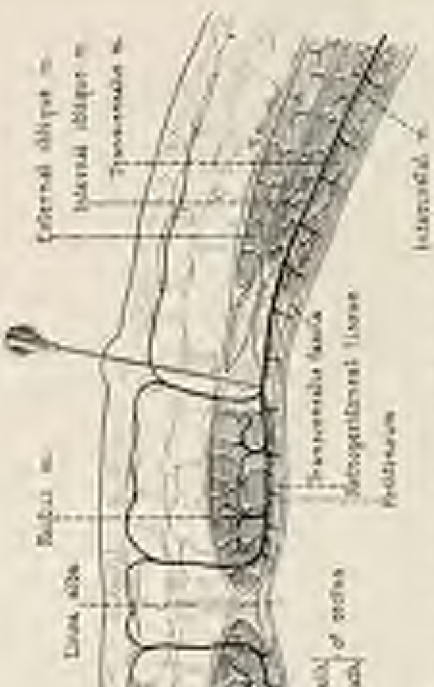

Fig. 267.—Cross-section of part of the anterior abdominal wall, showing the method of making deep injections within the rectus sheath.

The abdominal field-block is the procedure usually employed, because it is more easily and quickly accomplished than the paravertebral block and requires no special long and delicate training. It affords almost complete relaxation of the abdominal wall and perfect anesthesia of the parietal peritoneum within the blocked area. If gentleness is used, the abdominal organs may be explored, provided the incision is long enough to allow the hand to steal into the abdominal cavity without force. This is most easily done after the lips of the wound are clamped and raised. In the majority of cases there is no

sharp pain during gentle exploration, but only an abdominal sensation referred to the epigastrium, such as that due to intestinal colic. The sensation ceases with the exploration which ordinarily is of very short duration. Some patients require just enough ether or gas to make

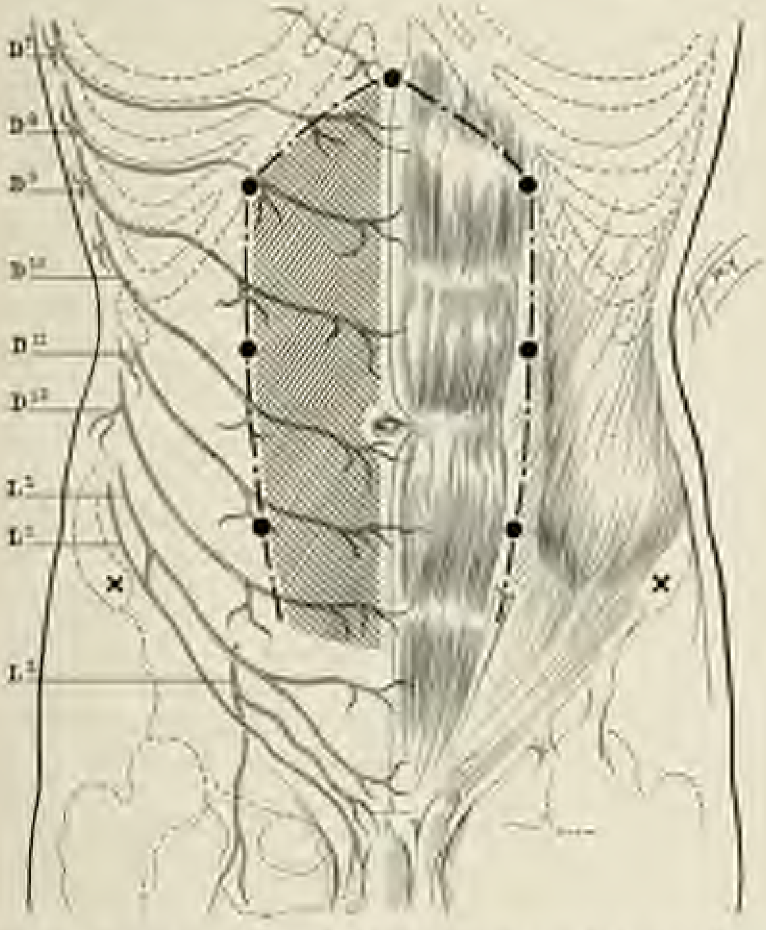

Fig. 268.—Extensive abdominal field-block. The dots mark the sites of puncture along the lateral margin of the rectus sheath: the dotted lines, the subcutaneous infiltration.

them lose consciousness during this stage of the operation. If the excitation period is reached, exploration becomes impossible, owing to lack of relaxation, which can only be obtained by bringing the patient to the surgical stage of anesthesia; and in such cases he loses the benefit

of the regional method. It is, therefore, wise to insist on the necessity for a judicious use of ether or gas during exploration.

In many cases it is possible by the field-block alone to perform a gastro-enterostomy; in rare instances, a gastrectomy, provided the patient is very thin, the stomach free from adhesions and not retracted by pathologic processes, and the lesion not too high. The mesocolon must, besides, be not too short and extreme gentleness used in manipulating the organs.

2. *Paravertebral Block.*—The paravertebral block (page 214) from D^{5} to D^{10} permits of median and paramedian incisions above the umbilicus, but does not widen the scope of operations capable of being performed by means of the field-block procedure. It gives a wider anesthetic area which, although covering a segment of the trunk, is of no use for exploration purposes. Its limited possibilities, therefore, mitigate against its use for laparotomy only, and preference is given to the field-block procedure.

If there is any doubt as to the issue of the exploratory laparotomy, the paravertebral block should be extended to D^{12}; the resulting anesthesia offering possibilities for a radical operation on the stomach. Splanchnic analgesia may also be associated with the abdominal field-block to meet the purpose of a gastric resection. The condition of the patient is the best guide. At times it may be advisable to use the field-block alone, even if the clinical findings are highly suggestive of a radical operation. In such cases gas-oxygen should be preferred to ether narcosis. If the desired muscular relaxation cannot be obtained without the addition of a few drops of ether to the gas-oxygen, there is no objection to resort to this combined method, which is certainly better than ether alone.

GASTROSTOMY

Field-block is the procedure of choice for gastrostomy. Two or three wheals are raised along the left costal margin, from the ensiform cartilage to the tip of the eleventh rib, and needle No. 3 (8 cm.), attached to the syringe filled with the 0.5 per cent. solution, is passed through each of the wheals in turn and advanced in a direction perpendicular to the surface of the skin, until its point reaches the muscle

layer beneath the deep fascia, where the solution is distributed fanwise along a plane parallel with the costal margin. When the deep injections have been completed, a subcutaneous infiltration is made by joining all the wheals together and the region is lightly massaged. The

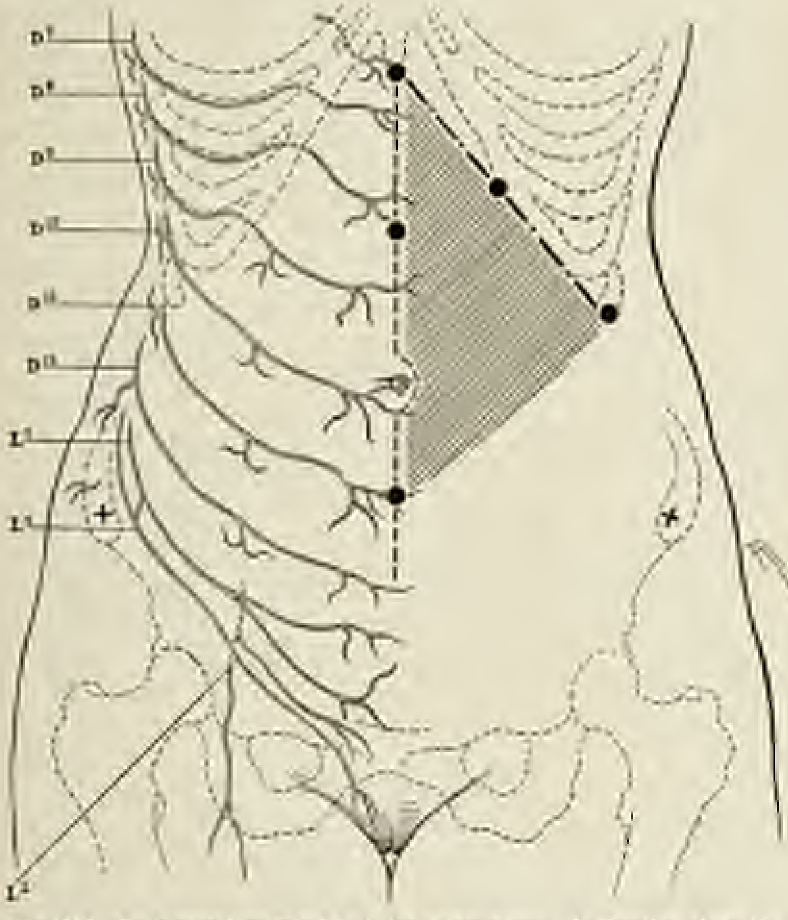

Fig. 269.—Left costal margin block for gastrostomy. Infiltration along the midline, as illustrated above, only serves to control bleeding; it can be omitted without interfering with the analgesia resulting from the costal margin block alone.

result is a wall of anesthesia created across the path of the intercostal nerves supplying the left rectus muscle and the overlying structures from the xiphisternum to the umbilicus. Not more than 50 c.c. of the 0.5 per cent. solution is necessary for these injections (Fig. 269).

GASTRO-ENTEROSTOMY

After inducing the abdominal field-block as described on page 362 the patient is asked to turn on his left side, then on his right side, and the splanchnic injections are made by the posterior route (page 358). It is easier to begin with the injections on the right side. The patient is then told to resume his original position on his back and ten minutes are allowed for the anesthesia to set in.

In case of palliative operation to relieve pyloric obstruction due to carcinoma of the stomach, the poor condition of the patient occasionally contraindicates the injection of large doses of the anesthetic fluid. The abdominal field-block is quite sufficient for them. A few whiffs of gas-oxygen or ether are given to those patients whose general sensibility to pain has not been modified by the disease. Just enough of these narcotics will be given to abolish consciousness during the short period of surgical manipulations preceding the gastro-intestinal anastomosis. In many cases, especially in very lean patients, it is possible to carry out all the steps of the operation after the induction of the field-block alone, provided gentleness is used in manipulating the transverse mesocolon and picking up the intestinal loop. This can be done with very little discomfort to the patient by putting the mesocolon to mild and gradual stretch and slipping in two fingers, thus opening the way for a clamp to the jejunal loop.

GASTRECTOMY

Apart from the method of intraspinal block (page 452), there are two procedures by which gastrectomy can be painlessly performed, viz., the paravertebral block and the splanchnic analgesia associated with the abdominal field-block.

1. *Paravertebral Block.*—With the patient lying in the lateral recumbent position, bilateral paravertebral injections are made from D^6 to D^{12} according to the technic described on page 219. When injecting D^{12} the needle must be advanced deeply and 20 c.c. of the 1 per cent solution distributed on the lateral aspect of the vertebral column, close to its anterior convexity. The resulting anesthesia is that of a large segment of the trunk involving the entire abdominal wall; and, if all

the rami communicantes have been reached by the solution, manipulations of the organs of the upper abdominal cavity are painless. This procedure, therefore, affords opportunity for laparotomy as well as for the surgical treatment of the diseased viscera without the use of supplementary injections. The anesthesia is associated with complete relaxation of the abdominal wall and negative intra-abdominal pressure, a condition which is of the highest advantage in abdominal surgery.

It occasionally happens that the incision of the abdominal wall is the only painless step of the operation, without its being possible to

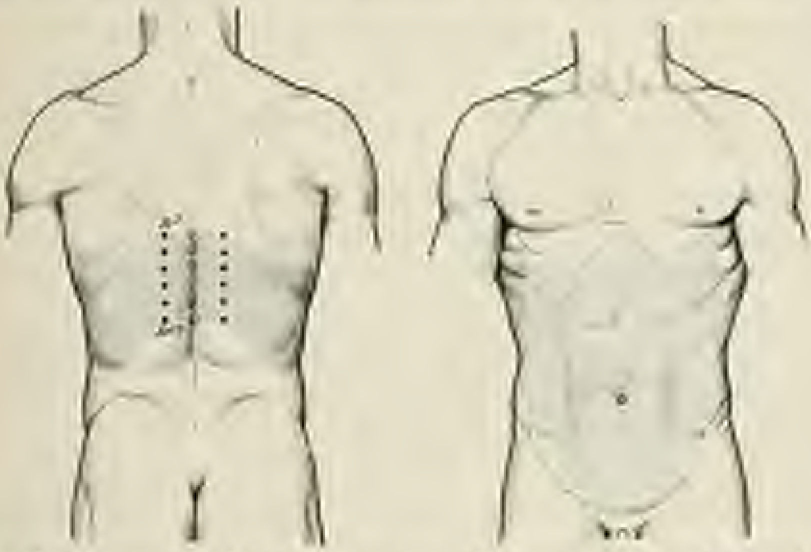

Fig. 270.—Paravertebral block for gastrectomy. Extreme zone of anesthesia resulting from the injection of D^7 to D^{12}. The abdominal field block is superfluous

give plausible reasons for the existing condition. Such a partial failure is not always due to poor technic, since it may occur also in the hands of the most experienced. It can, however, be remedied by injecting the solar plexus according to Braun's or Pauchet's technic (page 356). If this supplementary injection proves to be a failure, it will be necessary to have recourse to general narcosis, beginning by a first-stage anesthesia (Crile's analgesia), so as to make sure that the pain complained of is not simply a state of discomfort which is very frequently present in gastric operations. As a matter of fact, pulls on the stomach

are attended by a nauseated condition and, occasionally, by reflex vomiting, which are relieved by deep breathing and the application of wet sponges on the anterior aspect of the neck. The first-stage narcosis relieves the condition in any case and allows the operation to be completed satisfactorily both for the surgeon and the patient. As already inferred, the paravertebral block is a delicate procedure which, notwithstanding long training, requires skill and experience. Partial failures should not discourage the beginner, but serve as a stimulant to acquire experience.

2. *Splanchnic Analgesia.*—The anesthesia of the abdominal wall is realized by the field-block procedure described on page 362. The patient is then placed in the lateral recumbent position and the splanchnic analgesia induced (page 358), beginning on the right side, which seems easier or at least more convenient.

The anesthesia resulting from the foregoing procedure involves a fairly wide portion of the anterior abdominal wall and a reasonable area of the posterior wall of the abdominal cavity lying under the direct influence of the surgical maneuvers. Of the anterior abdominal wall, the anesthesia includes all its structural layers and extends from the xiphisternum to a little below the umbilicus, and comprises the field lying between the lateral margins of the recti muscles. But it must not be forgotten that the intermediate lateral portions of the abdominal cavity situated between the anterior and the posterior zones of anesthesia are unaffected by these injections and consequently retain their ability to react to painful stimuli. More gentleness must be used when operating by means of this procedure.

SPLENECTOMY

The spleen, being in the same segment as the stomach, can be excised by means of the same regional anesthetic procedures.

1. *Paravertebral Block.*—Bilateral injection of the last six thoracic pairs, deep injections being made at the level of the twelfth, just the same as for gastrectomy (page 368).

2. *Splanchnic Analgesia.*—The abdominal field-block is first induced with the patient in the supine position. Its extent varies with the in-

cision adopted; blocking along the costal margin and the lateral margin of the rectus muscle, as described on page 362, being sufficient for a left rectus incision. For other incisions involving the abdominal wall lateral to the left rectus muscle, the left paracostal block is a better procedure, since it supplies a greater zone of anesthesia with more complete relaxation. A wall of anesthesia is created along the left costal margin, from the ensiform cartilage to the tip of the eleventh rib, involving the entire thickness of the abdominal wall. A subcutaneous infiltration is then made along the middle line extending from the ensiform cartilage to about midway between the umbilicus and the pubis. About 50 c.c. of the 1 per cent. solution, or an equal mixture of the 0.5 and the 1 per cent. solutions, is sufficient for the paracostal block. The subcutaneous injections are made with the 0.5 per cent. solution, using about 60 c.c.

The splanchnic nerves are then injected in the manner described on page 358, bilateral injections being necessary in every case.

OPERATIONS ON THE GALL-BLADDER

For a simple drainage of the acutely inflamed gall-bladder the septic condition of the patient prompts the use of a simple local infiltration along the line of incision. Cholecystostomy does not require more than an abdominal field-block, since the fundus of the gall-bladder is insensitive, but tractions on the organ should be avoided because they are referred to the deeper structures, especially the parietal peritoneum, and give rise to sharp pain. The procedure of the abdominal field-block is accomplished in the same manner as for a gastrostomy (page 368), with this difference, that it is given on the right side. The infiltration along the costal margin from the xiphisternum to the tip of the eleventh rib gives a complete relaxation of the upper portion of the abdominal wall. Exploration is possible if much gentleness is used, but it is sometimes necessary to administer a first-stage narcosis.

Cholecystectomy can be performed by the foregoing procedure provided supplementary injections are made along the cystic duct after opening the abdomen. The surgical maneuvers are, however, not always painless. There are two other procedures by which the

operation can be performed very satisfactorily, viz., the paravertebral block and the splanchnic analgesia.

1. *Paravertebral Block.*—Paravertebral injections from D^6 to D^{12} (page 214) associated with the abdominal field-block along the right costal margin are sufficient in the majority of thin relaxed patients, but in the average cases it is necessary to perform the bilateral paravertebral block from D^1 to D^{12}. When injecting D^{12}, 20 c.c. of the solution are distributed deeply on the lateral aspect of the vertebral column, close to its anterior convexity. In weak patients it is customary to use a mixture of equal parts of 0.5 and 1 per cent. solution for the paravertebral injections, thus reducing the strength of the anesthetic fluid to 0.75 per cent., and consequently the dose administered. Exploration of the stomach, duodenum, and appendix can easily be made if the lips of the wound are clamped and raised and gentleness used in slipping the hand into the abdominal cavity.

2. *Splanchnic Analgesia.*—The abdominal field-block is first induced in the following manner: With the patient lying in the supine position, wheals are raised along the right costal margin, from the xiphisternum to the tip of the eleventh rib, and from that point vertically downward to the iliac crest. Needle No. 3 (8 cm.), attached to the syringe filled with the 0.5 per cent. solution, is introduced through each of these wheals in succession and advanced toward the muscle layer within which the solution is distributed fanwise. Subcutaneous injections are finally made along the lines joining the wheals together, except the first to the last. Two walls of anesthesia are thus created across the path of the intercostal nerves supplying the right half of the abdominal wall. These walls are perpendicular to the surface of the skin and meet at the tip of the eleventh rib. When this has been done, splanchnic analgesia is induced according to the technic described on page 358. Bilateral splanchnic injections are necessary, after which ten minutes are allowed before the operation is begun.

The use of morphin and scopolamin should be avoided in jaundiced patients, who, as a rule, have a blunt sensibility to pain and are very sensitive to these narcotics as well as to the anesthetic drug.

OPERATIONS ON THE LIVER

Abscesses of the liver are drained by simple infiltration along the line of incision.

For the *removal of an echinococcus cyst* and marsupialization of the cystic cavity, or approximation of its walls, the paravertebral block (page 214) is very satisfactory, the number of nerves blocked depending on the extent of the operation. The resection of the costal margin, in case of large cysts of the anterior surface of the liver, can thus be accomplished without supplementary injections. The paravertebral block from D^5 to D^{12}, on the right side only, meets the requirements of such operations, whatever be the localization of the cyst in the liver.

It is possible to begin the operation by local infiltration along the line of incision and complete it by injecting the solution in the deeper structures as the operation progresses. This is not an elegant procedure. There is, however, no objection to its use in this and similar cases when the wound is left open.

COLOSTOMY. CECOSTOMY

For *colostomy of the transverse colon* wheals are raised on both sides along the costal margin, from the xiphisternum to the tenth costal cartilage, and from that point downward along the lateral margin of the rectus muscle to about the level of the umbilicus. Needle No. 3 (8 cm.), attached to the syringe filled with the 0.5 per cent. solution, is passed through each of these wheals in succession and the solution distributed fanwise within the rectus sheath. The wheals are finally joined together, except the two last, by subcutaneous lines of infiltration, and the region lightly massaged. In lean patients the operation is performed painlessly, owing to the flatness of the anterior abdominal wall and its consequent proximity to the posterior wall of the abdominal cavity. The transverse colon can thus be handled without putting the mesocolon on a stretch. In thin relaxed patients exploration is always possible if gentleness is used. The lips of the wound are clamped and raised and the hand slipped into the abdominal cavity without force. A few whiffs of ether or gas are given to those patients who cannot stand a short period of abdominal sensation without distress. In fat

patients, or those with tense rigid abdominal wall, the distance between the anterior and posterior walls of the abdominal cavity is considerably increased and the meso relatively short. The bowels have, besides, a tendency to bulge out as soon as the abdomen is opened; so that still more gentleness is required than when handling lean patients. Exploration is somewhat difficult, but yet possible, with the aid of a first-stage narcosis. Abdominal field-block is the procedure of *choice* for transverse colostomy, although in a few cases the weight of the patient makes of him a bad subject for the regional method alone. The association of a short period of inhalation narcosis does not in any way deprive the method of its advantages over the exclusive use of general anesthesia.

The *left rectus colostomy or sigmoidostomy* may be performed by two procedures, viz., the abdominal field-block and the paravertebral block.

1. *Abdominal Field-block.*—With the patient lying in the recumbent dorsal position, wheals are raised along the left costal margin, from the xiphisternum to the tip of the eleventh rib, and from that point to the iliac crest (Fig. 271). Needle No. 3 (8 cm.) or No. 4 (10 cm.), attached to the syringe filled with the 0.5 per cent. solution, is passed through each of these wheals in succession and deep injections made within the muscle layer of the abdominal wall, followed by subcutaneous injections joining all the wheals together, except the first to the last. Along the costal margin the solution is distributed fanwise in a plane perpendicular to the surface of the skin and passing through the wheals; from the costal margin to the iliac crest the injections are made in a similar manner. Two walls of anesthesia meeting at the level of the tip of the eleventh rib are thus created, cutting off the nerve supply of half of the abdominal wall. The quantity of solution injected varies from 100 to 200 c.c., according to the weight of the patient.

2. *Paravertebral Block.*—With the patient lying on his right side, the paravertebral block (page 214) from D^8 to L^2 is induced on the left side, and the patient asked to resume his position on his back, if the cutaneous territory of the injected nerves has become insensitive. If part of it is still sensitive, supplementary paravertebral injections

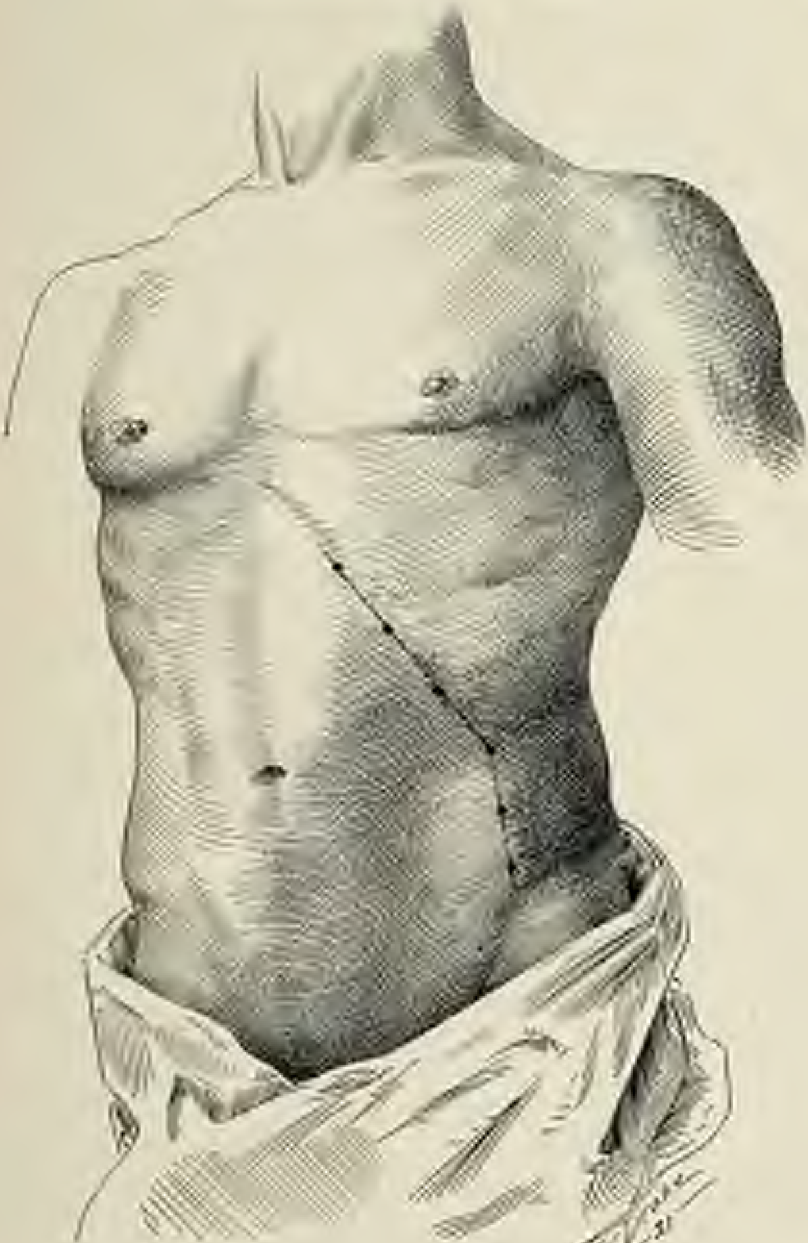

Fig. 271.—Field-block for left rectus colostomy. The dots are the points of entrance of the needle along the costal margin and from the tip of the eleventh rib to the *iliac* crest.

are made of the nerve or nerves responsible for the existing condition, and ten minutes allowed before the operation is begun.

Of the two procedures, the paravertebral block is the one of choice, because it affords a wider field of anesthesia and greater facility in handling the bowel, in case the mesocolon is short; but it is more difficult than the abdominal field-block, and in order to give it successfully, fairly good training is required. Paravertebral block thus performed does not abolish the abdominal sensation present during exploration, but it lessens it to a certain extent. In the majority of cases the colostomy is performed painlessly without the aid of ether or gas.

If regional anesthesia is to be induced by the average surgeon, preference should be given to the abdominal field-block because it is easily and quickly accomplished and requires no special long and delicate training. As a matter of fact, it is the procedure usually employed, being sometimes associated with just enough ether or gas to make the patient lose consciousness during exploration. The abdominal field-block for colostomy affords almost complete relaxation of the abdominal muscles and perfect anesthesia of the parietal peritoneum within the blocked area, and possesses all the advantages attributed to the abdominal field-block procedure employed for exploratory laparotomy (page 362).

If the foregoing procedures are accomplished on the right side, *cecostomy* is performed with equal advantage.

APPENDECTOMY

There are four procedures available for appendectomy in the quiescent stage of appendicitis, viz., three field-block and one paravertebral.

1. *Field-block A* (McBurney's Incision).—With the patient lying in the supine position, four wheals are raised on the right side of the abdominal wall; the first, about 2 fingerbreadths (4 cm.) *posterior to and above* the anterior superior spine of the ilium; the second, vertically above the first at about the level of the tip of the eleventh rib or of the costal margin; the third, over the right rectus muscle, between the umbilicus and the anterior superior iliac spine; the last, at the level of the inguinal canal, a little below the internal ring (Fig. 272). Needle No. 3 (8 cm.) or No. 4 (10 cm.), attached to the syringe filled with the

0.5 per cent. solution, is introduced through wheals 1 and 2 in turn and advanced in a direction perpendicular to the surface of the skin, then more and more obliquely until the point of the needle penetrates the muscle layer within which the solution is distributed fanwise in a plane at right angles to the surface of the skin and passing through the side 1-2 of the quadrilateral figure formed by joining the wheals together. Through 1 deep injections are besides made in the direction of the iliac bone with which the needle comes in contact at the level of the iliac crest. Through 2 the injections are also made in the direction of the costal margin on a distance of about 3 fingerbreadths from the

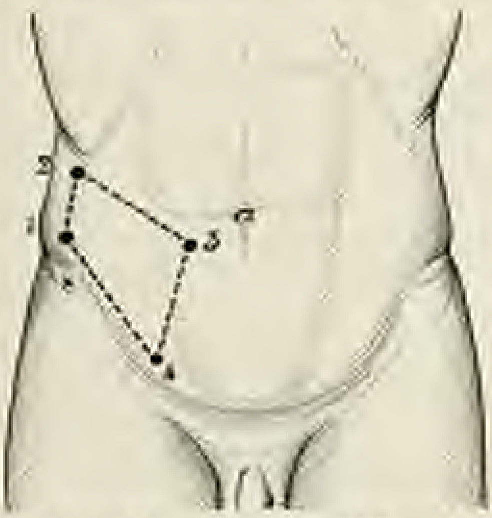

Fig. 272.—Field block for appendectomy (McBurney's incision).

point of entrance of the needle, toward the ensiform cartilage. Subcutaneous injections are finally made along the sides of the quadrilateral. From 100 to 150 c.c. of the 0.5 per cent. solution is sufficient to secure perfect anesthesia of the abdominal wall. Equal parts of the 0.5 and the 1 per cent. solutions may be used with advantage, especially in tense, rigid abdominal walls, if the operation is to be started immediately after the last injection.

This procedure is very satisfactory for McBurney's incision, which is made about 1 inch medial to the anterior superior iliac spine. In thin relaxed patients with loose cecum it is possible to slip in a clamp

and pick up the appendix without inducing pain after the lips of the wound have been gently and gradually retracted wide open. The table, in certain cases, is tilted one way or another, so as to free the region from the bulk of the intestines. Pulls on the cecum are painful because of tractions exerted simultaneously on the posterior wall of the abdominal cavity which, naturally, is not influenced by the injections made in its anterior wall. If gentleness is used, it is possible to raise the cecum to the level of the surgical wound and complete the operation with the minimum discomfort to the patient. If this cannot be done, owing to an adherent cecum or appendix, it is preferable to give a first-stage inhalation narcosis during the short period of painful maneuvers, so that the patient may not have a bad recollection of his operation, which is so detrimental to home education. In fat patients the depth of the diseased viscus beneath the surface of the skin is the principal drawback of the operation performed by the field-block procedure induced according to this technic. The association of gas-oxygen meets, however, every purpose, especially if the psychic condition of the patient has not been dulled by a preliminary dose of morphin and scopolamin (page 12). The injection of the meso-appendix, as proposed by Pauchet and others, can be made, but the author's opinion is that it does not amount to much in abolishing the conduction of painful stimuli applied simultaneously to the appendix and cecum. At all events, the injection is usually made at the base of the meso, as soon as the appendix is brought out between the lips of the wound.

2. *Field-block B* (McBurney-Weir's Incision).—With the patient lying in the horizontal dorsal position, two wheals are raised: the one, about 2 fingerbreadths (4 cm.) posterior to and above the anterior superior spine of the ilium, and the other, below the costal margin, at about the level of the tip of the eleventh rib. The needle is passed through each of these wheals in succession and the 0.5 per cent. solution distributed fanwise within the muscle layer, as well as subcutaneously, between the costal margin and the iliac crest (Fig. 273). The injections are always made in a plane at right angles to the surface of the skin. This is called the "costo-iliac block." It affords a wide zone of anesthesia and possesses the same advantages attributed to the

first procedure. It is more easily and quickly accomplished, but does not give as completely dry an operative field because of the absence of circuminjection. This lack of anemia does not, however, prevent it from being considered a very good procedure.

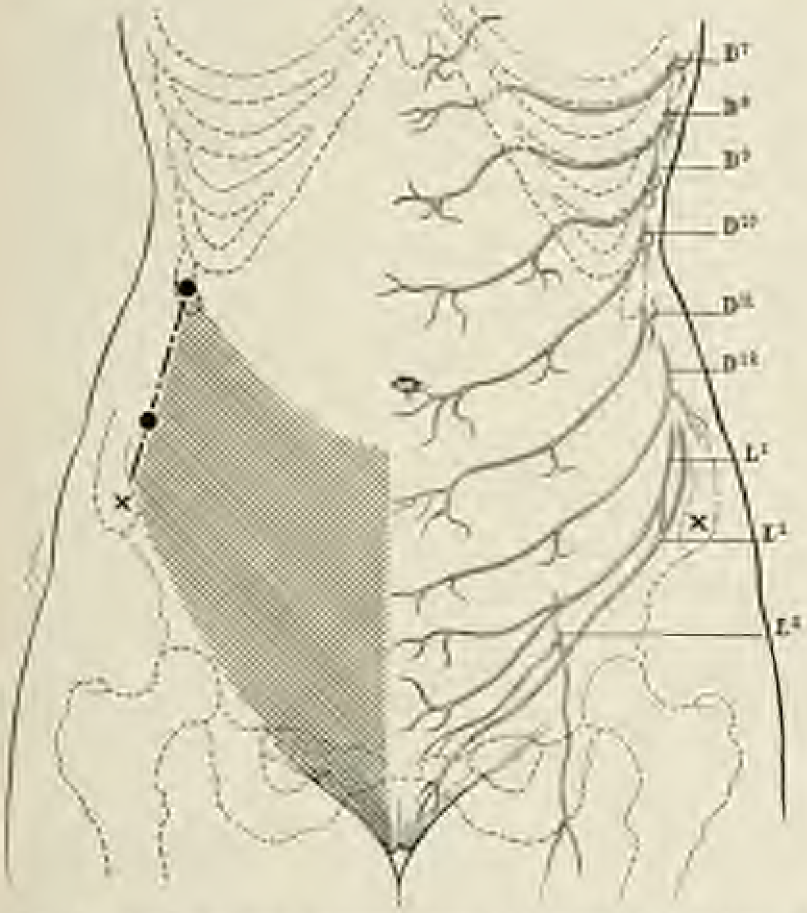

Fig. 275.—Costo-iliac block for appendectomy (McBurney-Weir's incision). The two dots mark the points of entrance of the needle, and the interrupted line the direction of the anesthetic wall created across the nerve supply of the region.

3. *Field-block C* (Battle-Jalaguier-Kammerer Incision).—With the patient lying in the same position as before, *i. e.*, on his back, wheals are raised along the right costal margin, from the xiphisternum to about the level of the tip of the eleventh rib, and from that point downward

to the iliac crest (Fig. 274). The needle, connected with the syringe filled with the 0.5 per cent. solution, as before, is introduced through each of these wheals in succession and advanced in the deeper structures, where fanwise injections are made within the muscle layer. Subcutaneous

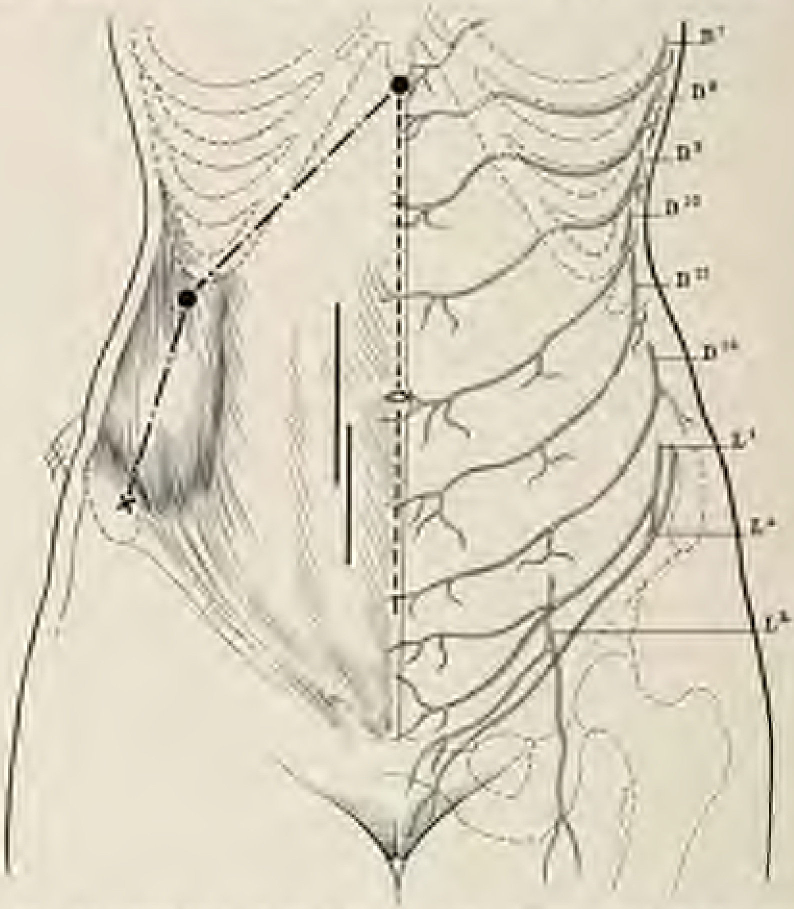

Fig. 274.—Field-block of the right half of the abdominal wall affording opportunities for cholecystectomy as well as for appendectomy. Right rectus incision can be made at any level.

injections are then made which join all the wheals together except the first to the last. From 100 to 150 c.c. of the solution are thus injected in planes parallel to the surface of the skin, cutting off the innervation of half of the abdominal wall, thus affording a very wide zone of anesthesia which establishes most favorable conditions for exploring the

abdominal organs, the gall-bladder especially. If splanchnic analgesia (page 358) is associated with this field-block procedure, it is possible to complete the operation without the use of a general anesthetic, provided gentleness is used in handling the abdominal organs, since the parietal anesthesia covers only the right half of the abdominal wall.

The injections along the costal margin may be started from a point midway between the xiphisternum and the tip of the eleventh rib, if the extent of the anesthesia thus reduced seems satisfactory for a low incision. But since it occasionally happens that appendicular symptoms disguise lesions of the gall-bladder or duodenum, or are associated with pathologic conditions of these organs, which are only diagnosed after exploration, it is by far preferable to avail oneself of such procedure as would permit of a modified operation, in case of need. For the resection of a pelvic appendix, however, individual cases must be considered.

4. *Paravertebral Block.*—With the patient lying on his left side, paravertebral injections are made on the right side from D to^{10} L^2 (pages 219 and 240) for McBurney's or Roux' incision, or from D^7 to L^2 for the Battle-Jalaguier-Kammerer incision. Apart from the abdominal sensation which varies with the individual, exploration is possible and the operation can be completed without the aid of general anesthesia, provided gentleness is used during the surgical maneuvers. Its association with splanchnic analgesia (page 358) widens the surgical possibilities of the procedure. The liberation of an adherent or retrocecal appendix can thus be painlessly accomplished.

For appendectomy in the acute stage of the disease intraspinal block (spinal anesthesia) is the procedure of choice, because of the resulting abdominal silence which establishes favorable operative and postoperative conditions. Abscesses are drained by infiltrating locally along the line of incision.

UMBILICAL HERNIOTOMY

The abdominal field-block is the procedure usually employed for umbilical herniotomy. It is the procedure of choice, whatever be the volume of the hernia or the weight of the patient. Strangulation is

not a contraindication to the method of regional anesthesia; on the contrary, it is imperative.

With the patient lying on his back, wheals are raised as illustrated in Fig. 275, and through each of these wheals a needle of convenient

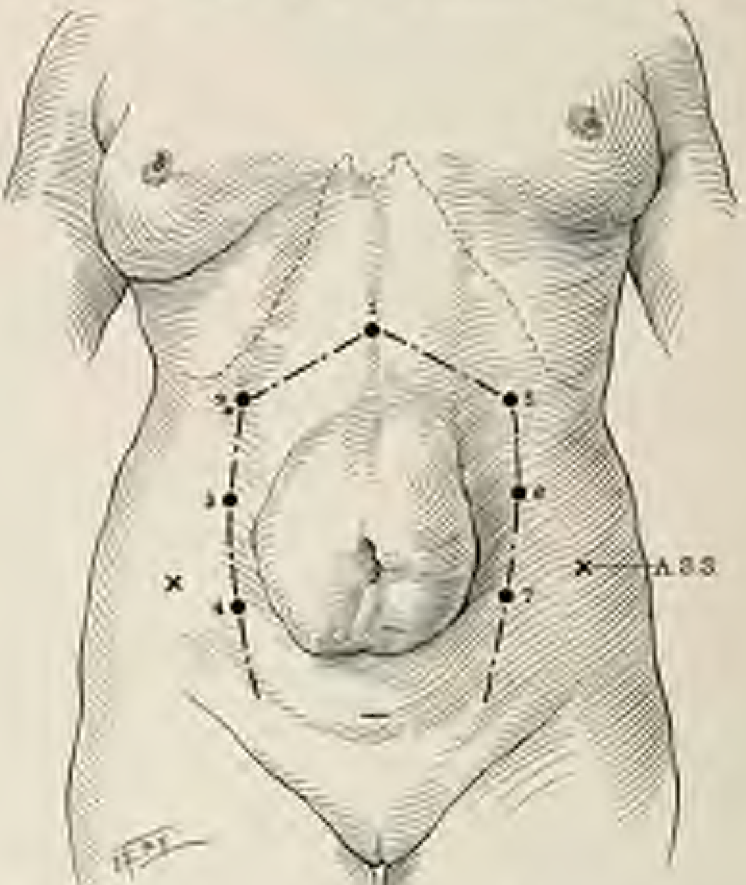

Fig. 275.—Field-block for umbilical herniotomy. The lateral rows of wheals (2-3-4 and 5-6-7) are here raised beyond the lateral margin of the recti muscles owing to the size of the hernia; *A.S.S.* is the anterior superior iliac spine.

length, connected with the syringe filled with the 0.5 per cent. solution, is passed and advanced toward the muscle layer within which the solution is distributed fanwise as usual. Subcutaneous injections are then made joining all the wheals together except the two lowest. The nerve supply of the enclosed area is thus cut off, including that of the

corresponding portion of the parietal peritoneum, thus making it possible to manipulate the neck of the sac and liberate extensive intestinal adhesions without causing pain. Resection of the adherent omentum is not painful.

If the lateral rows of wheals are raised still more laterally, it is possible to make a long transverse incision and resect at the same time a considerable amount of fat, so cumbersome in certain patients. The Mayo operation is performed, without the least discomfort to the patient, by means of this procedure, which affords perfect anesthesia of all the structural layers of the abdominal wall, including the peritoneum.

Fig. 276.—Cross-section of the abdominal wall through the umbilical hernia, showing the sites of puncture and position of the needle, indicated by the arrows.

The quantity of the 0.5 per cent. solution varies with the extent of the blocked area and the weight of the patient. From 250 to 300 c.c. is the usual dose injected in very fat women. It must be remembered that when injecting large quantities of novocain-adrenalin solution, the adrenalin solution (1 : 1000) should be added to the approximate volume of the anesthetic fluid needed for the particular case, at the rate of 10 drops per 100 c.c. The injections are made slowly, to minimize the risk of after-effects due to rapid absorption.

EPIGASTRIC HERNIOTOMY

Injections are made along the costal margin and the lateral margin of the recti muscles, as for laparotomy (page 363). This procedure offers the same advantages for the repair of a postoperative hernia as for the radical cure of a primary epigastric hernia. If gentleness is used, adhesions of the viscera to the anterior abdominal wall are liberated painlessly.

POSTOPERATIVE HERNIOTOMY

Individual cases must be considered. If the hernia lies on the midline and is subsequent to a pelvic operation, fanwise injections are made along the lateral margin of the recti muscles, starting a little above the umbilicus and extending to the pubis, the solution being distributed within the rectus sheath. This is called "suprapubic block." For a hernia subsequent to appendectomy, injections are made along a vertical line joining the tip of the eleventh rib to the iliac crest (costo-iliac block) in case of McBurney's incision, the injections being always in such a way as to distribute the solution within the muscle layer, as well as subcutaneously, thus creating a wall of anesthesia across the path of the nerves supplying the operative field. If the hernia is situated at a higher level, such as that which occasionally follows Bevan's incision, the injections are made along the costal margin from the xiphisternum to the tip of the eleventh rib and from that point downward to the iliac crest (paracosto-iliac block).

INGUINAL HERNIOTOMY

Two procedures are available for inguinal herniotomy, viz., the field-block and the paravertebral block. It is customary to induce the field-block because it is more easily accomplished, although it takes a little longer than the paravertebral.

The nerve supply of the inguinal region must now be reviewed to enable the reader to understand the procedures described hereafter. The inguinal canal and the spermatic cord, together with the soft structures of the immediate neighborhood, receive their sensory innervation from the two last dorsal and first three lumbar nerves. Sensory fibers for the testis are also contained in the spermatic sympathetic plexus.

The eleventh and twelfth dorsal nerves approach the region from the lateral aspect of the trunk and run downward and inward between the internal oblique and transversalis muscles toward the lateral margin of the rectus muscle. After giving off filaments to the oblique and transverse muscles of the abdomen, and to the integuments covering these structures, they pierce the rectus sheath, and supply that muscle and the pyramidalis. The *iliohypogastric* and *ilio-inguinal nerves* also come from the lateral aspect of the trunk and run downward and inward toward the region (page 234), the first passing between the internal oblique and transversalis muscles, while the second remains subperitoneal as far as the anterior superior iliac spine. It is then and there that the ilio-inguinal nerve pierces the transversalis muscle and meets the iliohypogastric nerve. The ilio-inguinal nerve and the inguinal branch given off by the iliohypogastric gradually place themselves between the external and internal oblique muscles on nearing the internal inguinal ring, and the iliohypogastric nerve continues its course inward like the twelfth thoracic nerve. In the absence of this branch, the iliohypogastric nerve itself accompanies the ilio-inguinal nerve and both of them become occupants of the inguinal canal, lying on the anterior surface of the spermatic cord. The *genitocrural nerve* approaches the internal inguinal ring from the posterior wall of the abdominal cavity, after crossing the external iliac artery, and enters the inguinal canal on the posterior aspect of the spermatic cord, sometimes on its medial aspect. The genitocrural nerve may be replaced in the inguinal canal by the branch coming from the iliohypogastric nerve.

From the foregoing brief résumé it is clear that, if a wall of anesthesia is created obliquely across the anterior abdominal wall from the anterior superior iliac spine to the umbilicus, the entire innervation of the operative area will be cut off, with the exception of the genitocrural, which must be injected at the internal inguinal ring if field-block is the procedure employed. The sensory element of the spermatic sympathetic plexus is controlled by injecting the structures of the spermatic cord.

1. *Reducible Hernia* (Braun's Technic).—With the patient lying in the supine position, two wheals are raised: the first, 3 fingerbreadths

medial to the anterior superior spine of the ilium; the second, exactly over the horizontal ramus of the pubis at the external inguinal ring. Through the first wheal the muscle layers lying between the wheal and the ilium are infiltrated fanwise. About 20 c.c. of the 0.5 per cent. novocain-suprarenin solution are injected in the following manner: Needle No. 3 (8 cm.) or No. 4 (10 cm.), according to the weight of the patient, is introduced perpendicular to the surface of the skin and advanced in that direction through the aponeurosis of the external

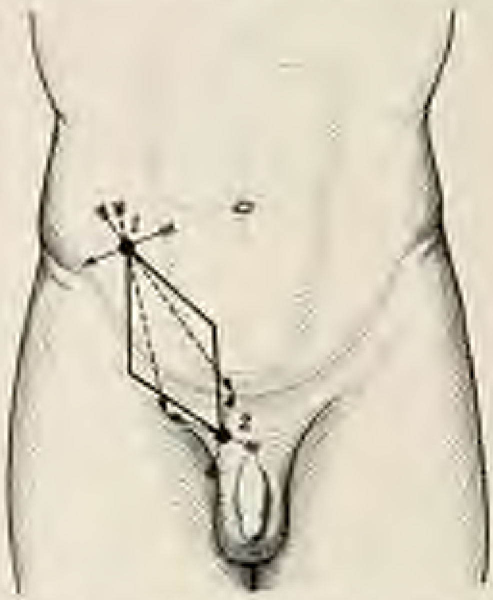

Fig. 277.—Field-block for reducible inguinal hernia (after Braun). The dotted lines indicate the direction in which the subaponeurotic injections are made; the continuous lines, that of subcutaneous infiltration.

oblique muscle and through the muscle layers of the internal oblique and transversalis. The solution is injected slowly and continuously while the needle advances in the depth. The needle is then partially withdrawn and reintroduced twice again, each time in a more oblique direction toward the ilium until the point of the needle strikes the bone. The solution thus distributed blocks the iliohypogastric and ilio-inguinal nerves. From the same point of entrance further injections of from 10 to 20 c.c. of the same solution are made in a fork-shaped

manner beneath the aponeurosis of the external oblique muscle on each side of the internal inguinal ring. The needle is then passed through the second wheal and 10 c.c. of the same solution are injected fanwise over the pubis, the point of the needle each time coming in contact with the bone. The needle is then advanced upward, and 10 c.c. of the same solution are injected in a fork-shaped manner beneath the aponeurosis in the inguinal canal, along the spermatic cord. The skin is finally injected subcutaneously in the form of a rhombus (Fig. 277). From 75 to 100 c.c. of the 0.5 per cent. solution are sufficient for this procedure. For bilateral herniotomy the injections are made on both sides before the operation is begun.

2. *Unilateral Reducible Hernia* (Author's Technic).—With the patient lying in the dorsal decubitus position, three wheals are raised at 1, 2, and 3 (Fig. 278). Wheal 1, called the "para-iliac wheal," is placed about 2.5 cm. above and medial to the anterior superior spine of the ilium; wheal 2, called the "pubic wheal," lies just above the pubic spine; wheal 3, called the "subinguinal wheal," is raised just below Poupart's ligament and lateral to the femoral artery. The operator usually stands on the side to be injected. Needle No. 3 (8 cm.) or No. 4 (10 cm.), according to the weight of the patient, is connected with the syringe filled with equal parts of the 1 and 0.5 per cent. solutions, passed through the para-iliac wheal 1, and the solution distributed fanwise within the muscle layers down to the transversalis fascia in a plane perpendicular to the surface of the skin and extending from the crest of the ilium toward the umbilicus, the last injections being made within the rectus sheath at a short distance from the umbilicus (Fig. 279). A subcutaneous infiltration made along this plane completes the wall of anesthesia which blocks the iliohypogastric, ilio-inguinal, and the two lower thoracic nerves. Injection should be slow, steady, and continuous while the needle is advanced as well as when it is withdrawn. From 50 to 60 c.c. of the combined solutions (0.75 per cent.) is used in this injection in the average cases. The needle is then passed through the pubic wheal 2, and deep injections are made, with about 10 c.c. of the same solution, along the horizontal ramus of the pubis, on each side of the spermatic cord, into the pubic attachment of the rectus muscle,

and extending a little beyond the midline. In making the injections to the outer side of the spermatic cord, care must be exercised not to puncture the femoral vein. This is easily avoided by controlling the position of the point of the needle with the left forefinger placed below Poupart's ligament, at the level of the femoral ring, and in contact with

Fig. 278.—Field-block for unilateral reducible hernia, illustrating on one side the technic and on the other the nerve supply: 1, Para-iliac wheal; 2, pubic wheal; 3, subinguinal wheal; ×, anterior superior iliac spine.

the horizontal ramus of the pubis. One fingerbreadth to the inner side of the femoral artery is a limit beyond which the needle must not trespass. Through the same site of puncture subcutaneous injections are then made along the horizontal ramus of the pubis to a point 3 to 4 cm. beyond the midline, using about 5 c.c. of the same solution for this injection. The needle is next inserted through the subinguinal

wheal 3 and deep injections are made beneath Poupart's ligament, followed by subcutaneous injections parallel with and along this ligament. This injection serves to control overlapping branches coming from the

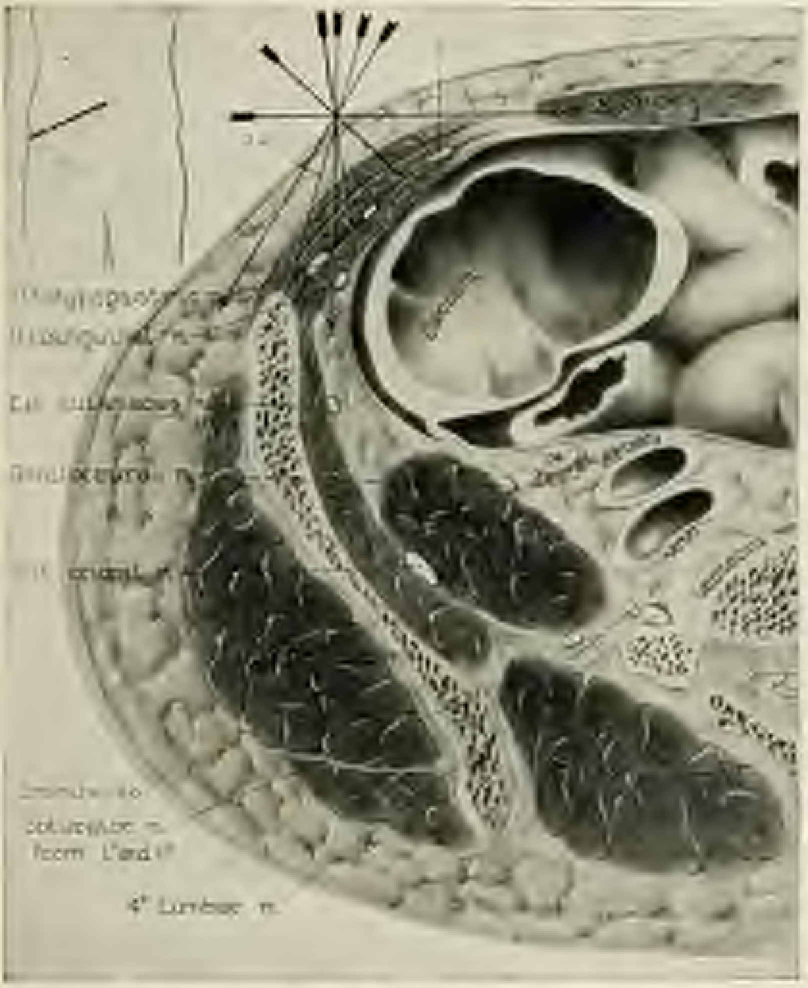

Fig. 279.—Section passing through the para-iliac wheal and umbilicus. The arrows indicate the directions of the needle during the injections through the para-iliac wheal.

anterior crural, external cutaneous, and crural branch of the genito-crural nerve and facilitates the approximation of the deep layers. About 10 c.c. of the 0.5 per cent. solution are needed for this.

The cord is then grasped between the thumb and index-finger of the left hand at the level of the external inguinal ring, or at the point where the cord crosses the pubis, and the needle inserted through the pubic wheal 2. The position of the operator for the injection of the cord depends on the side to be injected, the injection being best made from the pubic spine upward. The cord structures are thus transfixed in an

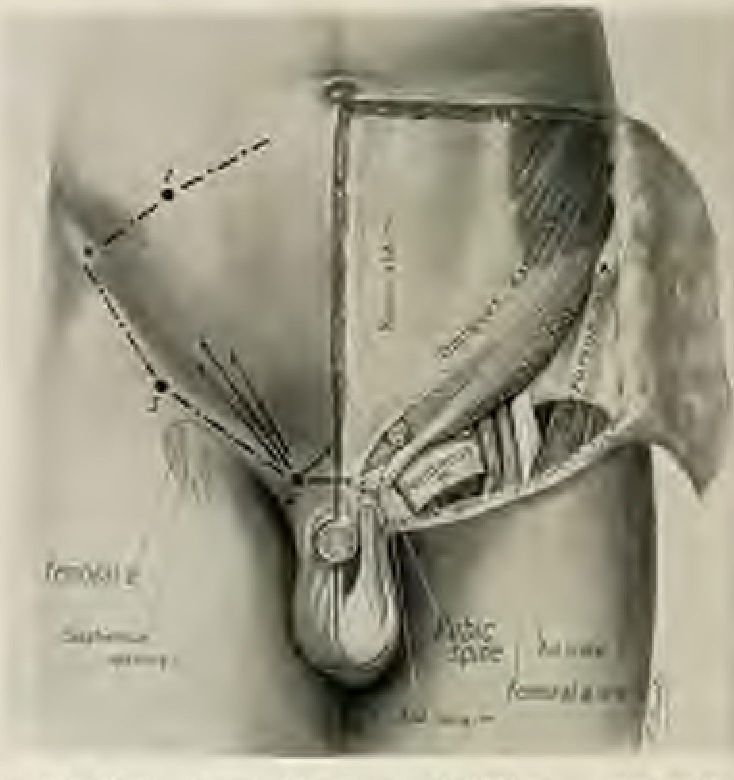

Fig. 290.—Unilateral inguinal herniotomy. Field-block procedure on the right. Dissection on the left showing the external inguinal ring and the subinguinal anatomic features.

upward direction and injected with about 5 c.c. of the 1 per cent. solution, care being exercised not to traumatize these structures by multiple punctures. Hematoma of the cord is of no clinical significance, but should be avoided. The cord is then lightly massaged to hasten the diffusion of the injected fluid.

The last injections are made at the margins of the internal ring.

They surround the neck of the sac and are intended for blocking the genitocrural nerve. If the internal ring can be easily defined by palpation, needle No. 4 (10 cm.), attached to the syringe filled with the 1 per cent. solution, is passed through the pubic wheal 2 and advanced subcutaneously to a point just medial to the margin of the ring. The fascia is then pierced at this point and a small quantity of the solution injected beneath it. Similar injections are made lateral to and above the margins of the ring, using from 5 to 10 c.c. of the 1 per cent. solution. If the internal ring cannot be found by palpation, the injections are

Fig. 281.—Injection of the spermatic cord. Note the direction of the needle upward.

made midway between the pubic and anterior superior iliac spines, about 2.5 cm. above Poupart's ligament.

In thin relaxed patients it is possible to pass the needle from the pubic wheal upward and outward in the inguinal canal instead of advancing it in the subcutaneous tissue. The needle thus passes along the medial aspect of the spermatic cord until its point reaches the medial margin of the internal ring, where the injection is made. The position of the point of the needle is all the time controlled by the tip of the left forefinger (Fig. 282). The needle is then partially withdrawn and reintroduced toward the lateral margin of the ring, passing this

time to the outer side of the cord. The last injection is made at the upper margin of the ring. The region is lightly massaged to hasten the diffusion of the solution in all directions.

If the reduction of the hernia is not maintained of itself with the patient in the supine position, the mass reappearing as soon as the pressure is released, the cord structures are injected in the following manner: Reduction is maintained with the last three fingers of the left hand, while the cord is grasped between the thumb and the forefinger (Fig. 283) and injected as previously described (page 390). In such cases it is best to make the injections around the internal ring from

Fig. 282.—Injections at the margins of the internal ring. The needle is inserted through the pubic wheal and advanced upward and outward in the inguinal canal, under the control of the tip of the left forefinger.

above, through the para-iliac wheal, in order to prevent a possible puncture of the sac and its contents.

Anesthesia is usually induced with 100 c.c. of the 0.5 per cent. and 50 c.c. of the 1 per cent. solution. Less solution is used in lean patients, and 50 c.c. more of the 0.5 per cent. solution if the patient is very obese.

The foregoing field-block procedure has been devised to produce adequate anesthesia for all types of inguinal herniotomy and repair, whatever be the individual modification in the operative technic adopted.[1] The occasional failure to anesthetize the genitocrural can be

[1] Gaston Labat and William B. Meeker, Surgery, Gynecology, and Obstetrics, March, 1922, pp. 398–403.

remedied by supplementary injections made after exposure of the internal ring, the injection being made at the ring, to the inner side of the spermatic cord, with about 2 c.c. of the 1 per cent. solution. The needle is next passed through the cord structures a little below the internal ring, and 2 c.c. more of the same solution injected, as it sometimes happens that the sensory element accompanying the sympathetic plexus is not reached by the injection made at the level of the pubic spine. If after one or two minutes' manipulation of the sac is still painful, the needle must be passed in the retroperitoneal tissue and the solution distributed around the neck of the sac. Pulls on the sac must

Fig. 283.—Manner of maintaining reduction of the hernia for the injection of the spermatic cord.

be gentle and gradual; rough handling gives rise to pain referred to the parietal peritoneum beyond the anesthetized area. Such partial failures are due to poor technic.

3. *Bilateral Reducible Hernia.*—The bilateral block (Fig. 284) is based on the principles described for unilateral herniotomy (page 387). The deep injections are made with a mixture of equal parts of the 1 and 0.5 per cent. solutions; the injection of the cord structures and inguinal ring, with the 1 per cent. solution; the subcutaneous injections, with the 0.5 per cent. solution. The total quantity of solution usually employed is 200 c.c. of the 0.5 per cent. solution, and 50 c.c. of the 1 per cent. solu-

tion, with 20 drops of adrenalin (1 : 1000) in all. If more solution is required for very obese patients, the 0.5 per cent. is preferable to the 1 per cent. solution, and not more than 50 c.c. containing 5 drops of adrenalin solution should be used, thus making a total of 250 c.c. of the 0.5 per cent. solution and 50 c.c. of the 1 per cent. solution. The opera-

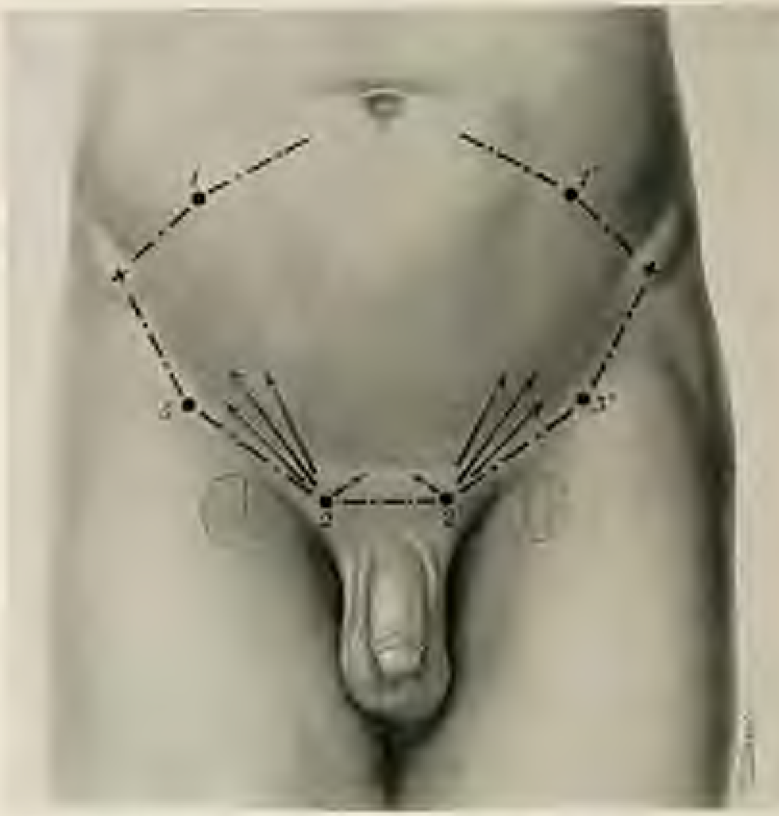

Fig. 284.—Field-block for bilateral reducible hernia. The technic is the same as for unilateral block: 1, Para-iliac wheal; 2, pubic wheal; 3, subinguinal wheal.

tion must be started on the side first injected. The results are identical with those obtained from the unilateral block. Intraspinal block (page 436) is more easily and quickly accomplished, but the resulting anesthesia is of much shorter duration, lasting only from one hour to one hour and a half.

4. *Irreducible Hernia.*—The technic is here different from that

employed in the case of reducible hernia owing to the distortion of the region. In Fig. 285, wheals 1, 2, and 3 have exactly the same position as in the case of reducible hernia: 1 is raised about 2.5 cm. medial to and above the anterior superior spine of the ilium; 2 lies over the pubic spine unless the deformity of the region renders palpation of that spine

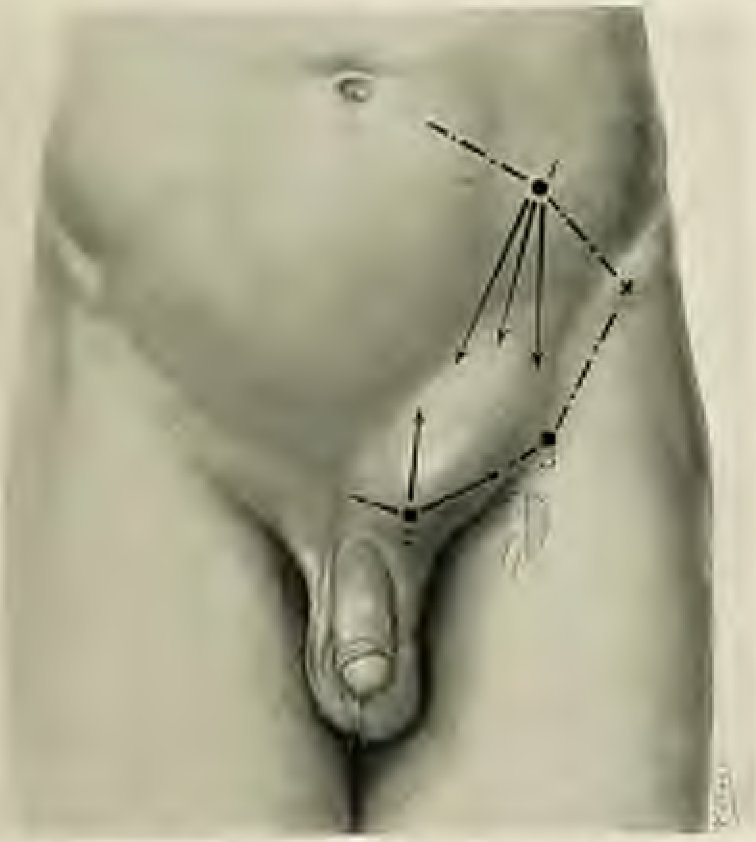

Fig. 285.—Field-block for irreducible inguinal herniotomy: 1, Para-iliac wheal; 2, pubic wheal; 3, subinguinal wheal. Note the direction of the arrows from the para-iliac wheal for the injection around the internal inguinal ring.

impossible, in which case it is raised on either side of the hernial mass, but always level with the pubic bone; 3 is lateral to the femoral artery and at the lateral margin of the hernial mass just below Poupart's ligament (Fig. 280). With a needle of convenient length (8 or 10 cm. long), attached to the syringe filled with a mixture of equal parts of the 1 and

0.5 per cent. solutions, fanwise injections are made through the para-iliac wheal 1 down to the transversalis fascia, in a plane perpendicular to the surface of the skin and extending from the crest of the ilium toward the umbilicus, the last injections being made within the rectus sheath at a short distance from the umbilicus (page 387). Through wheal 2 the solution is distributed along the horizontal ramus of the pubis, close to the bone, and in the pubic attachment of the rectus muscle on the same side, great care being exercised not to transfix the hernial mass. Subcutaneous injections are also made over the horizontal ramus of the pubis extending a little beyond the midline. The needle is then passed through 3 and the solution distributed beneath Poupart's ligament, as well as subcutaneously along this ligament. A longer needle is connected with the syringe, introduced through the para-iliac wheal 1, and advanced subcutaneously in the direction of the arrows. On nearing the hernial mass, which is gently retracted downward by the left hand, the aponeurosis of the external oblique is perforated by the needle and the solution injected at the neck of the sac, laterally and above the mass, using 10 c.c. of the combined solutions. The solution spreads out in all directions and diffuses toward the genitocrural nerve. If this injection is not successful, supplementary injections are made after exposure. With experience, and especially if the anesthetic procedures are carried out gently, quietly, and unhurriedly, these supplementary injections are seldom necessary.

The injection of the cord through the pubic wheal (page 390) is here not a safe procedure, unless the parts held between the thumb and forefinger at 2 are composed essentially of the structures of the cord. In case of doubt as to the presence of the sac among the structures grasped, the solution is distributed deeply, as well as subcutaneously, in the direction of the arrows from 2, on both sides of and beneath the hernial mass which is retracted each time with the left hand to avoid its puncture. The cord is injected after exposure, the injection being made as near as possible the internal inguinal ring.

The total quantity of solution usually injected is 100 c.c. of the 0.5 per cent. and 50 c.c. of the 1 per cent. solution, much less being used in lean patients. The deep injections are made with a mixture of equal

parts of the 0.5 and 1 per cent. solutions; the subcutaneous infiltration, with the 0.5 per cent. solution.

In *strangulations*, simple infiltration along the line of incision with the 0.5 per cent. solution is all that is necessary; deeper injections depend on the pathologic changes of the hernia and of the surrounding structures.

5. *Inguinoscrotal and Recurrent Hernia.*—The procedure described for unilateral inguinal herniotomy is the one usually employed. If the reduction of the hernia is maintained of itself with the patient in the supine position, or by the application of light pressure after gentle taxis, the injections are made according to the technic described for reducible hernia (page 387); if not, the procedure employed in the case of irreducible hernia is the best. The genitocrural nerve is blocked from the para-iliac wheal; the cord structures are injected after exposure. It is not necessary to circuminject the base of the genitalia, as is done by Braun, Pauchet, and others, unless the surgical procedures are extended to the scrotum (page 410).

Paravertebral block (page 214) induced from D^{10} to L^{3} on the side of the lesion meets the requirements of inguinal and inguinoscrotal herniotomies, no matter what surgical technic is adopted and how large the hernia may be. But intraspinal block (page 436) is preferable in the case of old voluminous inguinoscrotal or sliding hernia on account of the greater ease it affords for restoring the hernial mass to the abdominal cavity.

FEMORAL HERNIOTOMY

Femoral herniotomy may be performed by two procedures, viz., the field-block and the paravertebral block. Field-block is the procedure usually employed, no matter what the size and consistency of the hernia, whether it be reducible or irreducible, strangulated or not.

1. *Field-block.*—Four wheals are raised as shown in Fig. 286. Wheal 1 is the para-iliac wheal of the procedure used for inguinal herniotomy. It lies 2.5 cm. medial to and above the anterior superior spine of the ilium. Wheal 2 is the pubic wheal raised over the pubic spine. Wheal 3 occupies the lateral margin of the hernial mass and lies below Poupart's ligament. Wheal 4 is placed at its lower margin. Through

the para-iliac wheal 1 fanwise injections are made in the manner described for inguinal herniotomy (page 387), involving the entire thickness of the abdominal wall and extending from the iliac crest toward the umbilicus, to a point about midway between the umbilicus and the lateral margin of the rectus muscle. About 50 c.c. of a mixture of equal

Fig. 286.—Field block for femoral herniotomy. Through 1 injections are made across the abdominal wall along the dotted line, and at the internal inguinal ring in the direction of the arrows. The pubes and obturator nerve are injected from 2; Poupart's ligament, from 3. From 4 the needle is passed beneath the hernial mass toward the neck of the sac.

parts of the 0.5 and 1 per cent. solutions are used for these injections. Through the same wheal a longer needle is passed and advanced subcutaneously in the direction of the internal inguinal ring; and, after piercing the aponeurosis of the external oblique muscle, 10 c.c. of the solution are distributed at the margins of the ring. If the swelling overlaps or distorts this region, subfascial injections are made on each

side of the hernial mass as far down as possible. Through the pubic wheal 2, 10 c.c. of the solution are distributed along the horizontal ramus of the pubis, and the needle is next passed in the obturator canal (page 249), where injection is made of from 5 to 10 c.c. of the solution. Through wheal 3 the solution is distributed on the lateral aspect of the hernia and along Poupart's ligament, as far as the anterior superior iliac spine. From wheal 4 injections are made beneath the hernial mass, while the mass is retracted with the left hand to avoid its puncture. Wheals 2, 4, and 3 are finally joined together by subcutaneous injections. All subcutaneous injections are made with the 0.5 per cent. solution. The quantity of solution required for this procedure does not exceed 100 c.c. of the 0.5 per cent. solution and 50 c.c. of the 1 per cent. solution. The anesthesia is always satisfactory except in very rare instances, when the sac is pulled out with too much force. If gentleness is used, supplementary injection of the neck of the sac is not necessary and the operation is performed painlessly. If the hernia is reducible, or reduction maintained of itself in the supine position, wheal 4 is dispensed with and Poupart's ligament injected from wheal 3, which is then raised just lateral to the femoral artery.

2. *Paravertebral Block.*—Paravertebral block (page 214) from D^{10} to L^{1} on the side of the lesion is an elegant procedure and needs no further injections locally. It is the procedure of choice for those who know how to induce it successfully.

CHAPTER X

GENITO-URINARY AND RECTAL OPERATIONS

Apart from the kidney and ureter, all the *organs of the pelvis* derive their sensory innervation from the pudendal plexus, originating from the sacral nerves and the coccygeal nerve, to which are added contributions from the sympathetic system (see page 255). The visceral branches of the pudendal plexus, chiefly derived from S^2, S^3, and S^4,

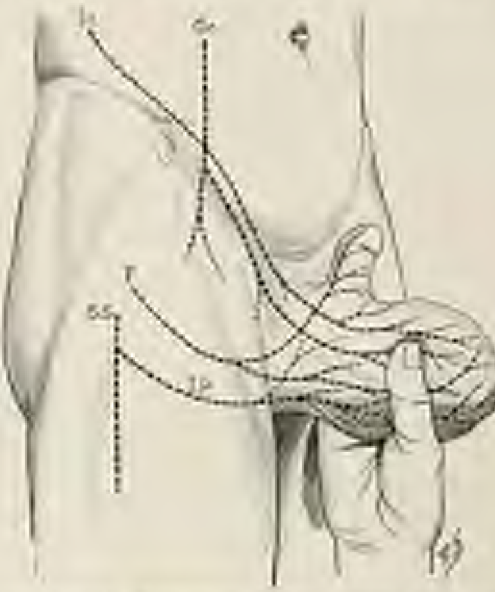

Fig. 287.—Diagrammatic illustration of the sensory nerve supply of the male external genitalia: *I-i.*, Ilio-inguinal nerve; *Gc.*, genitocrural nerve; *P.*, pudic nerve; *I.P.*, inferior pudendal nerve; *S.S.*, small sciatic nerve.

are joined by fibers coming from the hypogastric plexus and from the sacral portion of the sympathetic chain, to constitute the pelvic plexus of which the hemorrhoidal, vesical, prostatic, cavernous, and utero-vaginal plexuses are the smaller dependencies.

The *external genitalia* receive their sensory nerve supply from the pudendal plexus by means of the pudic nerve and pudendal branch of

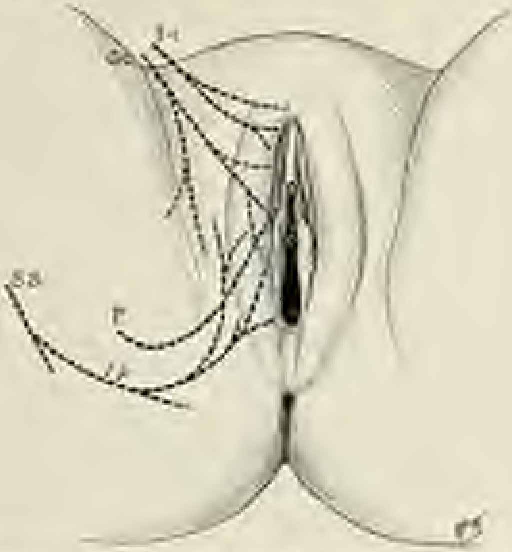

Fig. 288.—Diagrammatic illustration of the sensory nerve supply of the female external genitalia: *I-i.*, Ilio-inguinal nerve; *Gr.*, genitocrural nerve; *P.*, pudic nerve; *I.P.*, inferior pudendal nerve; *S.S.*, small sciatic.

Fig. 289.—Sensory innervation of the male perineum and anus.

the small sciatic which distribute filaments to the skin of the posterior aspect of the scrotum, the urethra and corpora cavernosa, the penis, and in women the greater part of the vagina, the labia minora, and posterior portion of the labia majora. The anterior surface of the scrotum and labia majora is supplied by the ilio-inguinal and genito-crural nerves, sometimes by the iliohypogastric nerve also. These nerves originate chiefly from L^1 and L^2.

Fig. 290.—Sensory innervation of the female perineum and anus.

The *perineum* and *anus* also receive their sensory innervation from the pudendal plexus by way of the pudic nerve and the pudendal branch of the small sciatic nerve (Figs. 289 and 290). The coccygeal plexus is distributed to the posterior part of the anal region.

The most important point brought out by the foregoing *résumé* is that the pudendal plexus is almost solely responsible for pain in the pelvic organs, perineum, and external genitalia, and that it can be reached by injecting all the sacral nerves. But it must not be forgotten that the surgical procedures carried out on one of the pelvic organs

are unavoidably and indirectly extended to the structures to which these organs are attached. It is, therefore, necessary for certain major operations to make provision for a much wider zone of anesthesia than is actually needed for the organs alone. The routes of approach of the pelvic organs must also be considered. If the perineal route is selected, the injection of the sacral nerves need not be supplemented by local infiltration or by field-block; but if the abdominal route is chosen, anesthesia of the abdominal wall is indispensable.

OPERATIONS ON THE KIDNEY

Paravertebral block is the procedure of choice for all operations on the kidney and the upper portion of the urinary tract. Nephrostomy, nephrectomy, pyelolithotomy, and ureterolithotomy are performed with equal advantage, provided deep injections are associated with the paravertebral block, in order to anesthetize the pedicle of the kidney and its immediate neighborhood. If these injections are not successful, luxation of the kidney is painful, and a first-stage narcosis must be resorted to during that stage of the operation. The anesthesia is induced in the following manner: With the patient lying on the side opposite the one to be injected, a hard thick cushion is slipped under his loin, to raise the operative region and render the different steps of the technic easier. Paravertebral injections are made from D^8 to L^2, as previously described (pages 219 and 240), using 5 c.c. for each dorsal nerve and 7 c.c. for each lumbar nerve. After making each injection from D^{12} to L^2 in the usual manner, the needle is advanced deeply and 8 to 10 c.c. of the solution distributed over the lateral aspect of these vertebræ, as close as possible to their anterior convexity. From 35 to 40 c.c. are thus injected. As is customary, the operative field is tested after a few minutes, and if any part thereof is still sensitive to painful stimuli, the responsible nerve or nerves are located and reinjected. If the skin of the upper part of the field does not seem to have been completely anesthetized, subcutaneous injections are made from D^8 along the corresponding rib laterally and extending as far as the costal margin. The existing condition of hypesthesia may be due to overlapping filaments from above.

Not more than from 90 to 100 c.c. are necessary for these injections. In weak patients it is preferable to use a mixture of equal parts of the 1 and 0.5 per cent. solutions, thus reducing the dose of novocain injected. In very poor surgical risks the 0.5 per cent. solution is quite sufficient to produce the desired result, but not more than 100 c.c. of that solution should be injected.

When the anesthetic procedure has been completed, the cushion is removed and the patient allowed to lie on his back during the usual

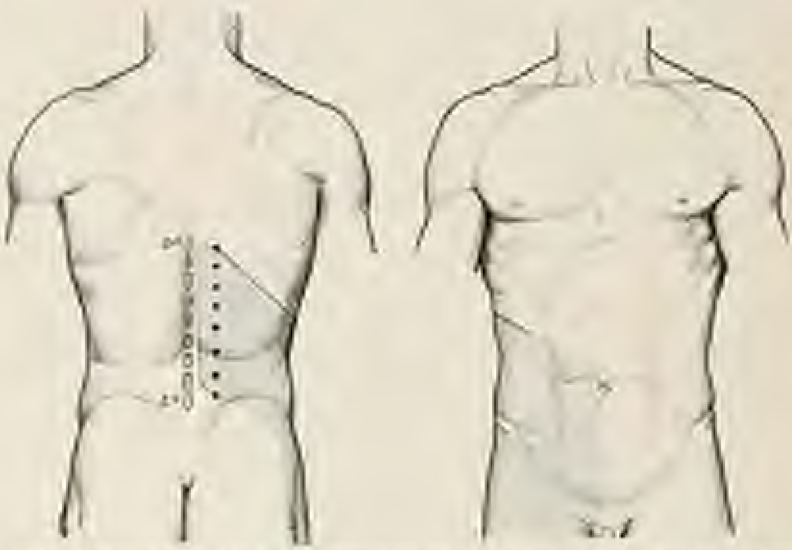

Fig. 291.—Paravertebral block for operations on the kidney. Resulting zone of anesthesia.

length of time allowed for the anesthesia to set in. This short rest puts the patient in a better condition to undergo the operation in the awkward position he assumes on the side which is still possessed of normal sensibility. The kidney rest must be well padded in order to minimize the discomfort due to position during the operation.

SUPRAPUBIC CYSTOSTOMY

Field-block is the procedure of choice for suprapubic cystostomy, whether used for drainage purposes, lithotomy, or as a means of approaching the prostate. Infiltration of the line of incision, in reducing

the vitality of the tissues in contact with septic contents of the bladder, establishes favorable conditions for infection and should be avoided. Field-block has the added advantage of affording muscular relaxation, thus facilitating the use of retractors. The anesthesia is induced in the following manner: Wheals are raised on the lateral margin of the recti muscles from the pubis to about the level of the umbilicus and fanwise injections are made within the rectus sheath, followed by subcutaneous injections along the lines joining the lateral wheals together.

Fig. 192.—Field-block for cystostomy in case of exploration of bladder necessitating the use of retractors: 1-1'-2'-2 are on the lateral margin of the rectus muscle; *R* is the point of entrance for injecting the space of Retzius.

From 50 to 75 c.c. of the 0.5 per cent. solution is sufficient for these injections. From a wheal raised on the midline, just level with the pubes, the needle is passed behind the symphisis and in close contact with it, and 20 c.c. of the same solution, or of the 1 per cent. solution, if there is any at hand, distributed fanwise in the space of Retzius. The operation is begun ten minutes after the last injection.

If there is any intention of catheterizing the urethra, or exploring the bladder to a certain extent, caudal block should be induced thirty

minutes before the anesthetic procedure for cystostomy is begun (page 277).

For a simple stab of the bladder and insertion of a drainage-tube it is sufficient to induce a rhombus-shaped field-block just above the pubes (Fig. 293). From two points of entrance lying one on each side of the median line, on the lateral margin of the recti muscles and about 3 fingerbreadths above the pubes, the needle is introduced in the direction of the dotted lines, and the 0.5 per cent. solution distributed fanwise

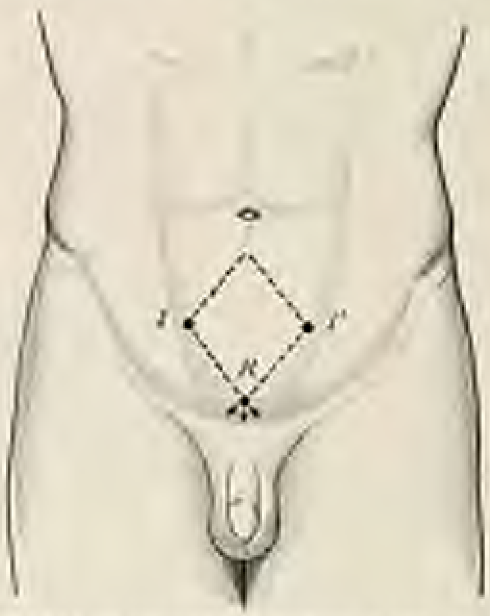

Fig. 293.—Field-block for suprapubic cystostomy in case of drainage only: 1 and 1' are the sites of puncture for the rhombus-shaped circuminjection; *R*, that for injecting the space of Retzius.

within the muscle sheath and subcutaneously. The space of Retzius is finally injected in the same manner as previously described. From 60 to 80 c.c. of the solution is required in this case.

SUPRAPUBIC PROSTATECTOMY

With the patient lying flat on his stomach, a cushion slipped under his hips, so as to raise the sacral region, the caudal block is induced with 30 c.c. of the 1 per cent. solution (page 277), immediately fol-

lowed by the transsacral block (page 260) from S^1 to S^5 with about 40 c.c. of the same solution. The patient is then asked to turn over on his back, after the cushion has been removed, and the suprapubic field-block is now performed in the manner described for cystostomy (page 404). The same procedure holds good for a single-stage, or a two-stage prostatectomy, no matter what operative technic is used.

Intraspinal block (spinal anesthesia), performed in the second or third lumbar space, is a safe procedure. It is employed by a great many surgeons, despite the delicacy with which it must be induced and the postanesthetic care often needed by this category of patients.

PERINEAL PROSTATECTOMY

With the patient lying flat on his stomach, a cushion under the hips, the caudal block (page 277) is induced with 30 c.c. of the 1 per cent. solution, immediately followed by the transsacral block (page 260) from S^1 to S^5, with about 40 c.c. of the same solution. The operation may be begun after the last injection, but it is preferable to wait about ten minutes. The sacral block thus accomplished is always followed by complete anesthesia, and is the method of choice for this operation, except when dealing with very fat patients in whom a low intraspinal block in the fourth lumbar space gives better results.

RESECTION OF THE BLADDER

Partial resection of the bladder for ulcer or carcinoma and resection of a diverticulum are performed by means of the same anesthetic procedures.

After inducing the sacral block in the same manner as for perineal prostatectomy, the last three lumbar nerves are injected according to the technic described on page 240, and the patient asked to turn over on his back. The suprapubic field block is then accomplished as previously described for cystostomy (page 404), and the patient is ready for the operation.

Intraspinal block (spinal anesthesia) between L^1 and L^2 is easier and quicker, and gives perfect anesthesia for the suprapubic incision also. It is preferred in fat patients.

OPERATIONS FOR VARICOCELE

Field-block is the procedure of choice for the surgical treatment of varicocele, no matter what operative technic is adopted. Two wheals are raised, the one 2.5 cm. medial to and above the anterior superior spine of the ilium, as for inguinal herniotomy (page 387), and the other over the pubic spine on the same side. Through the para-iliac wheal 1 (Fig. 294) fanwise injections are made in a plane perpendicular to the

Fig. 294.—Field-block for varicocele operation. Procedure for the excision of the veins only: 1, Para-iliac wheal; 2, pubic wheal, from which the internal ring is injected as shown by the arrows.

surface of the skin and extending from the iliac crest toward the umbilicus. The deep structures are first injected as far as the transversalis fascia and the iliac bone laterally, the last injections being made within the rectus sheath. A subcutaneous injection made along that plane completes the anesthesia of the inguinal region. Through the pubic wheal 2 needle No. 4 (10 cm.) is inserted and advanced in the inguinal canal as far as the internal inguinal ring, where injections are made at the margins of the ring, so as to block the nerves accompanying the

spermatic cord. The structures of the cord are then injected at that level. The cord must not be transfixed at the external ring or where it crosses the pubis, because of the possibility of creating a large hematoma which is most undesirable for such operation. In passing the needle up in the inguinal canal care should be exercised not to puncture one of the dilated veins; and, if the injection of the cord seems to be attended with some difficulty, it is preferable not to insist and inject it after its exposure, but before the coverings of the cord are incised.

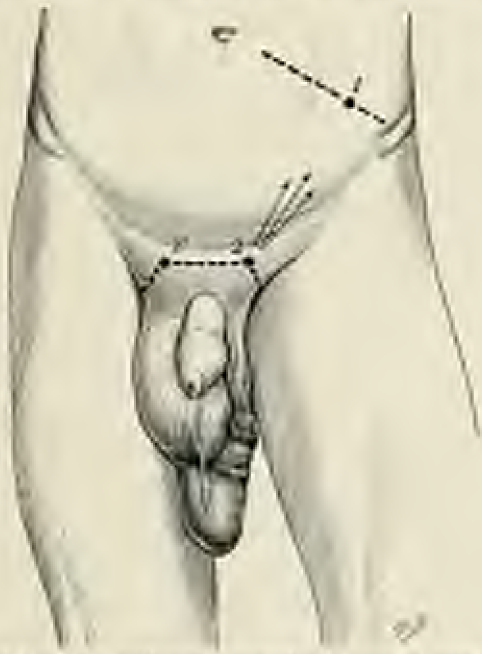

Fig. 295.—Field-block for varicocele operation in case of partial resection of the scrotum. Injection of the nerves approaching the region from the right inguinal canal; circuminjection at the base of the scrotum: 1, Para-iliac wheal; 2, 2', pubic wheals (see Fig. 296).

If the surgical procedures are extended to the scrotum (partial resection) the anesthesia of that part of the genitalia is realized by subcutaneous injections made around its base, supplemented by the blocking of the nerve supply approaching the scrotum from the opposite inguinal canal. This is best done by injecting the soft structures overlying the horizontal ramus of the pubis from a wheal raised over the pubic spine. The needle is introduced in all directions and the solution

distributed fanwise in close contact with the horizontal ramus of the pubis, thus transfixing and injecting at the same time the healthy spermatic cord. Through this wheal the needle is passed subcutaneously and injections are made around the base of the scrotum and extending to the other pubic wheal (Figs. 295 and 296).

Injections through the para-iliac wheal require from 50 to 60 c.c. of a mixture of equal parts of the 1 and 0.5 per cent. solutions. The cord takes 5 c.c. of the 1 per cent. solution; the genitocrural nerve

Fig. 296.—Blocking of the scrotum: 2 and 2' are pubic wheals; 3 and 4, genitocrural wheals. The spermatic cord and pubes are injected from 2 and 2'; subcutaneous injections are made joining all the wheals together, passing around the base of the scrotum.

injected from the pubic wheal, 5 c.c. of the 1 per cent. solution. The injections through the pubic wheal opposite the side of the lesion are made with 20 c.c. of the combined solutions; those around the base of the scrotum, with about 50 c.c. of the 0.5 per cent. solution.

EPIDIDYMECTOMY

For a unilateral epididymectomy the procedure described on page 387 for unilateral inguinal herniotomy is the procedure of choice. In

case of a bilateral operation, that for bilateral inguinal herniotomy (page 393) gives perfect anesthesia.

ORCHIDECTOMY

Anesthesia is induced in the same manner as for inguinal herniotomy (pages 387 and 393). If the scrotum is involved in the operation, subcutaneous injections are made around the base of the genitalia from one pubic wheal to the other, using about 50 c.c. of the 0.5 per cent. solution (Fig. 296).

OPERATIONS FOR HYDROCELE

The procedure employed for inguinal herniotomy (page 387) is the one usually adopted for hydrocele.

In a large hydrocele that extends high up the injection of the spermatic cord is not very easily accomplished from the pubic wheal by the usual technic. It is, however, sometimes possible to pass the needle in the inguinal canal and inject the cord structures, as well as the genitocrural nerve at the internal inguinal ring. The injections may also be carried from the para-iliac wheal. The injection of the cord structures may also be performed from the pubic wheal by transfixing these structures as they cross the horizontal ramus of the pubis, the injections being made fanwise along that bone and in close contact with it. These three ways of realizing the anesthesia of the spermatic cord and testicle are ordinarily sufficient to meet the requirements of individual cases. If the inguinal incision is prolonged downward on the scrotum, circuminjection of the base of the genitalia is necessary. The 0.5 per cent. solution is distributed subcutaneously from the pubic wheal backward in the genitofemoral fold to the perineum, and from the other pubic wheal in the genitofemoral fold on the opposite side, meeting the first injection at the perineum. In fat patients these injections must be made in two or three layers so as to secure perfect anesthesia.

OPERATIONS ON THE PENIS

Local infiltration of the prepuce is occasionally followed by slough, which makes the procedure a very poor one. It is preferable to anesthetize the entire penis in the following manner, as suggested by Braun:

Two wheals are raised, one on each side of the base of the penis, just medial to and below the pubic spine. With the penis drawn out and held in this position, a needle of convenient length, attached to the syringe filled with the 0.5 per cent. solution, is passed through these wheals in succession and advanced deeply along the ascending ramus of the pubis, as far as the corpora cavernosa, around which from 5 to 10 c.c. of the solution is distributed. This site of injection corresponds to the level where the corpora cavernosa leave the angle of the symphysis and unite with the shaft of the penis. These injections block the dorsal

Fig. 297.—Field-block of the entire penis: 1 and 2 are pubic wheals, raised just medial to and below the pubic spine, and used for blocking the dorsal nerves of the penis; the dotted lines indicate the subcutaneous infiltration around the base of the penis.

nerves of the penis, which can otherwise be anesthetized by distributing the solution on both sides of the suspensory ligament in close contact with the body of the penis, as it emerges from the angle of the symphysis. The needle is then partially withdrawn and reintroduced beneath the skin of the scrotum, where the solution is distributed around the root of the penis (Fig. 297), using about 20 c.c. of the 0.5 per cent. in the average adult, less in children.

The anesthesia thus produced involves the skin, prepuce, glans, corpora cavernosa, and urethra distal to the pubes. The procedure is recommended for circumcision, urethral fistule, plastic operations on

the urethra, amputation of the penis, and other operations on the parts anesthetized. For amputation of the penis with removal of glands, paravertebral block (pages 219 and 240) from D^{11} to L^{4} on both sides must be associated with the anesthesia of the entire penis by the foregoing procedure.

Operations for Hypospadias.—Plastic operations on the urethra near the glans (hypospadia glandis) is painlessly performed after anesthetizing the entire penis, as previously described. In the case of a penoscrotal hypospadias, the following procedure gives very satisfactory results, even in very young children. Two wheals are raised, one on each side, just medial to and below the pubic spine, through which the dorsal nerves of the penis are blocked, as for the anesthesia of the entire penis, by circuminjecting the pubic attachment of the corpora cavernosa, or distributing the solution on the dorsum of the penis, on both sides of the suspensory ligament. The needle is then passed around the base of the scrotum and the 0.5 per cent. solution distributed subcutaneously from one wheal to the other. The last injections are made beneath the skin overlying the pubes, joining the two wheals together.

External Urethrotomy.—The procedure of local infiltration, by which a finger is inserted into the anus and rectum to guide the needle in its progression toward the prostate, is not free from risk of infecting the deep structures, especially the ischiorectal fossa. Its use should be discontinued, although the anemia of the operative field produced by the adrenalin injected locally is of great value.

Caudal block is much better. The injection is made with 30 c.c. of the 2 per cent. novocain-adrenalin solution. Läwen's novocain bicarbonate solution (page 284) may be substituted for the usual novocain hydrochlorid solution, using a similar dose. The occasional failure incidental to the use of the caudal block alone, added to the inconvenience of the length of time taken by the anesthetic to produce its full effects, strongly recommend its association with the transsacral block, to realize what has already been called sacral block, which is followed by rapid anesthesia of long duration.

The *sacral block* is, therefore, the procedure of choice. Caudal injection (page 277) is made with 30 c.c. of the 1 per cent. solution,

immediately followed by the transsacral block (page 260), from S^2 to S^5.

HEMORRHOIDECTOMY

Operations for internal or external hemorrhoids have for many years been performed by means of local infiltration around the anus, no matter what operative technic is adopted. The procedure of local infiltration is no doubt very successful as far as anesthesia is concerned. Dilatation of the anal sphincter is one of the characteristic features of the method. It immediately follows the injection of the anesthetic fluid, thus reducing to a minimum the use of manual or instrumental dilatation; but the practice of inserting a finger into the anus, so as to prevent the point of the needle from entering the anal canal and rectum, is not without risk of contaminating healthy surrounding tissues. The introduction of the finger in the anus amid large hemorrhoidal tags is, besides, painful. The anemia of the operative field is of no value when the cautery is used.

Caudal block, with 30 c.c. of the 2 per cent. solution or the same quantity of Läwen's solution (page 284), gives almost the same results, as far as operative advantages are concerned, *i. e.*, perfect anesthesia with partial dilatation of the anal sphincter. It has already a marked advantage over local infiltration in that the injection is made at a distance from the operative field; but, as already stated, the occasional failures to produce anesthesia by means of caudal block alone and the slowness with which the anesthesia sets in, suggested the use of its association with transsacral block.

Sacral block induced in the same manner as for external urethrotomy (page 413) is the procedure actually recommended for hemorrhoidectomy, as well as for fissures in ano, rectal prolapse, and rectal polyp.

POSTERIOR RESECTION OF THE RECTUM

Control of the psychic element of the patient is here of the highest importance. For a single-stage Kraske operation the usual hypodermic injection of morphin $\frac{1}{4}$ gr. and scopolamin $\frac{1}{150}$ gr. is given one hour before the anesthesia is begun, and a second dose of the same strength injected immediately after the completion of the anesthesia. Indi-

vidual cases must, however, be considered in administering two doses of the combined narcotics (page 12), since these drugs are used to enable

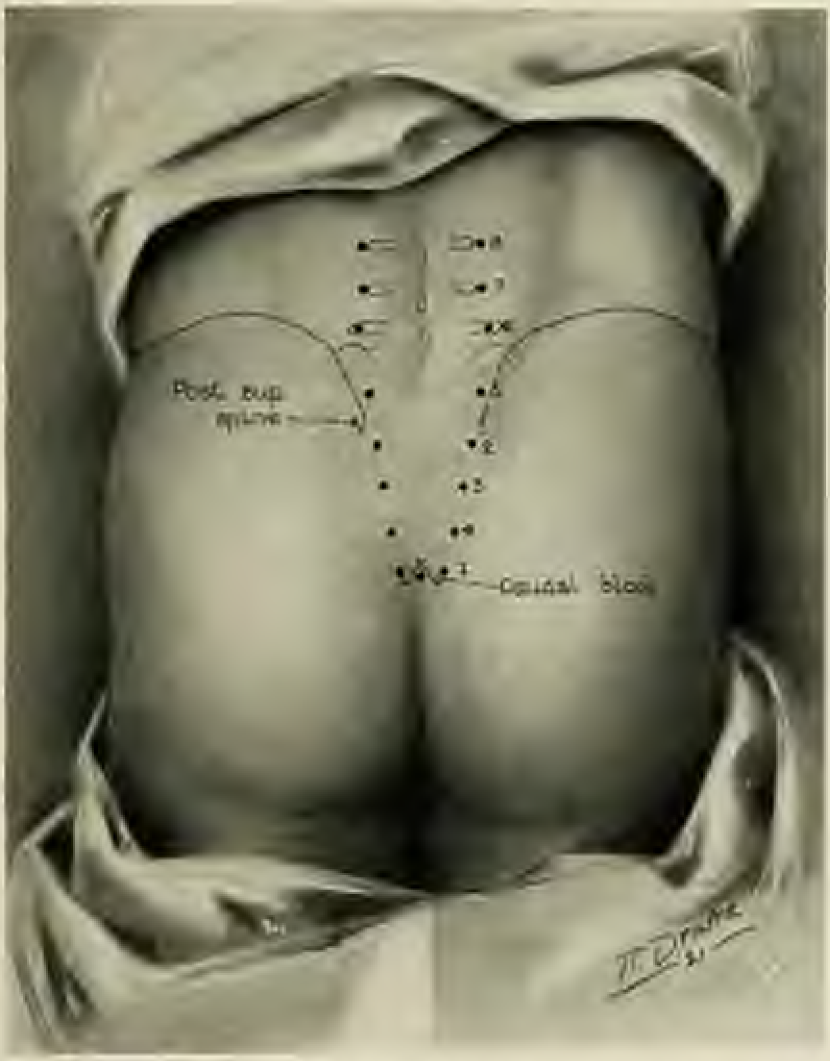

Fig. 298.—Sacral block and paravertebral block of the last three lumbar nerves: 1 to 5, Transsacral block; 6 to 8, paravertebral lumbar block.

the patient to feel more comfortable in that rather awkward position he must assume during the operation. For the colostomy in the two-stage operation one injection of morphin-scopolamin is, as a rule,

sufficient to dull the mentality of the patient, provided it is given one hour before the anesthesia is begun, and the colostomy is performed ten minutes after the anesthesia has been completed. In very nervous patients a second dose is given at the time of the anesthesia if the first dose does not seem to have produced the desired effect. The patient is prepared for the second-stage Kraske in the same manner as for the single-stage operation.

Anesthesia for the colostomy is induced in the manner described on page *373* for right rectus colostomy or sigmoidostomy.

For the Kraske or any modified posterior resection the best results are obtained by associating the sacral block (page 285) with the paravertebral block (page 240) of the last three lumbar nerves, starting with the caudal block, then passing to the transsacral block, and finishing by the paravertebral block (Fig. 298). The sacral canal is injected with 30 c.c. of the 1 per cent. solution; the posterior sacral foramina, with 40 c.c.; and the lumbar nerves, with not more than 60 c.c. of the same solution, thus making a total of about 130 c.c. of the 1 per cent. solution. Not more than the exact quantity of the solution must be taken in the syringe each time, so as not to exceed the total amount of 150 c.c., which is usually prepared beforehand. Beware of the capacity of the syringe (page 44), so as not to inject more than is desired.

The foregoing procedure (sacral block associated with paravertebral block) gives absolute anesthesia for the excision of a growth situated in the rectosigmoid juncture, and should not be modified according to the height of the lesion, but used integrally even if the lesion lies entirely in the rectum. It is always preferable to prepare the patient in such a way that no subsequent injections will be necessary if the surgical manipulations are extended beyond the contemplated area. For strictly anorectal lesions, it is sufficient to induce the sacral block only.

VAGINAL HYSTERECTOMY

With the patient lying flat on her stomach, a cushion slipped under her hips, the sacral block is induced as usual by a caudal injection of *30* c.c. of the 1 per cent. solution, immediately followed by the trans-

sacral block (page 285). The paravertebral block (page 240) is next accomplished from L^3 to L^5, and the patient asked to turn over on her back. The time taken to get the patient ready for operation is the usual length of time required for the anesthesia to set in.

ABDOMINAL HYSTERECTOMY

The anesthesia is induced in the same manner as for vaginal hysterectomy, after which the abdominal field-block is administered by dis-

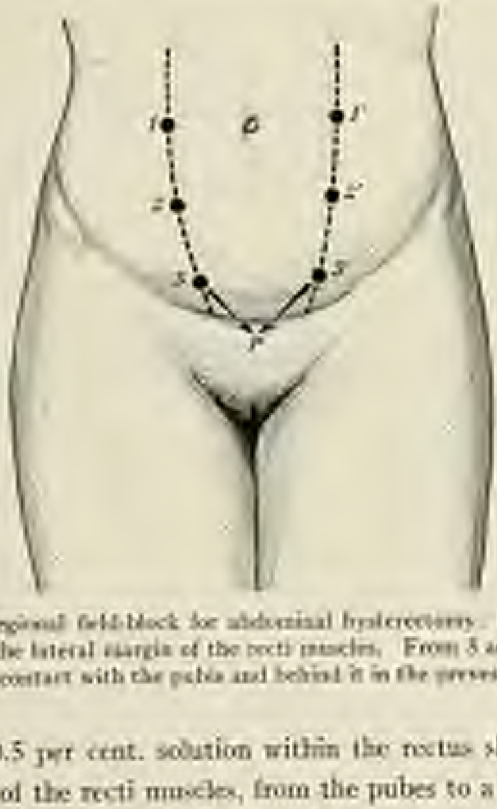

Fig. 299.—Regional field-block for abdominal hysterectomy. 1-1', 2-2', 3-3' are wheals raised on the lateral margin of the recti muscles. From 3 and 3' the injections are made in close contact with the pubis and behind it in the prevesical space.

tributing the 0.5 per cent. solution within the rectus sheath along the lateral margin of the recti muscles, from the pubes to a little above the umbilicus (Figs. 299 and 300). From 100 to 150 c.c. of the solution is sufficient for these injections. The incision is made after the patient has been placed in the Trendelenburg position. The patient is asked to breathe naturally through the mouth so as to relax the upper portion of the abdominal wall. In the Trendelenburg position the bowels have a tendency to drop down toward the diaphragm, on which they exert

abnormal pressure, which is quite bearable in the great majority of cases. Heavy packing of the abdominal cavity should, therefore, be avoided. Otherwise the resulting increased pressure on the diaphragm will give rise to nausea and vomiting, sometimes to a nauseated condition only, during which it is not easy to handle the patient (page 13). If gentleness is used in placing the retractors and opening them out, and unnecessary packing avoided, the operation can be performed very satisfactorily.

A wider anesthetic field may be realized by extending the paravertebral block to D^{10}. It affords at the same time the anesthesia of

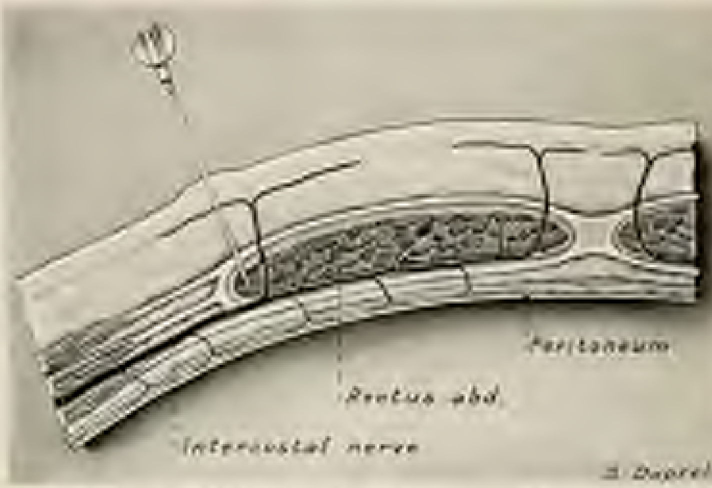

Fig. 300.—Abdominal field-block. The injections must be made within the rectus sheath, so as to reach the nerve before it supplies the muscle. The peritoneum and superficial structures are anesthetized at the same time.

the abdominal wall. This procedure is difficult, long, and tedious. It has besides the disadvantage of being trying for the patient and not quite as safe as the other procedures, considering the enormous dose of novocain required to produce anesthesia. Intraspinal block (spinal anesthesia) induced in the first lumbar space with 0.10 gm. of pure novocain is easier, quicker, and safer. Packing of the abdominal cavity must here also be gentle and reduced to a minimum. If the operation is likely to last more than one hour the abdominal field-block is induced with the 0.5 per cent. solution before the intraspinal injection is given;

the anesthesia thus produced will still be available for the closure of the abdominal cavity after the spinal anesthesia is worn off. Spinal anesthesia gives more gratifying results in very fat patients with indefinite bony landmarks. It should, therefore, be used in such patients in preference to the paravertebral procedures.

OVARIOTOMY

The same procedure employed for abdominal hysterectomy (page 417) is used for ovariotomy.

In the case of a very large ovarian cyst infiltration of the abdominal wall is all that is usually done before the operation is begun. Two parallel lines of anesthesia are established with the 0.5 per cent. solution, one on each side of the linea alba, at about 3 fingerbreadths from it, extending from the pubes to about 4 fingerbreadths above the umbilicus. The abdominal wall in such cases is unusually thin; the needle must be kept in the subcutaneous tissue. When the cyst has been sufficiently emptied, its pedicle is infiltrated with the 1 per cent. solution before ligation, or a few whiffs of ether or gas administered during this stage of the operation.

OPERATIONS FOR UTERINE PROLAPSE AND CYSTOCELE

Anesthesia is induced in the same manner as for vaginal hysterectomy (page 416), no matter what operative technic is adopted.

TRACHELOTOMY AND TRACHELORRHAPHY

The caudal block (page 277) with 30 c.c. of the 2 per cent. solution, when successfully induced, is ordinarily sufficient for these operations. The sacral block (page 285) gives more satisfactory results. The caudal injection is made with 30 c.c. of the 1 per cent. solution, immediately followed by the transsacral block of S^1 to S^3 with 40 c.c. of the same solution. Pulls on the cervix must be gentle and gradual, so as not to give rise to too much discomfort referred to territories beyond the anesthetized area.

PLASTIC OPERATIONS ON THE VAGINA

For the repair of vesicovaginal and rectovaginal fistulæ the sacral block gives very satisfactory results. Caudal block (page 277) is first induced with 30 c.c. of the 1 per cent. solution, immediately followed by the transsacral block (page 260).

Perineorrhaphy.—For small perineal tears it is customary to use local infiltration of the tissues in the immediate neighborhood of the lesion, with the left forefinger placed in the rectum, so as to guide the needle on the anterior surface of the rectum. This procedure, as already stated, however easy it may be, should be replaced by the caudal block (page 277) with 30 c.c. of the 2 per cent. solution, or the sacral block, if the surgeon cannot wait from twenty to thirty minutes to allow the anesthetic to produce its full effect. The caudal injection is made with 20 c.c. of the 1 per cent. solution, and is immediately followed by the transsacral injections of S^2 to S^4. The operation may be begun immediately after the last injection. The simultaneous anesthesia of the anal sphincter and lower end of the rectum makes the caudal block or the sacral block the procedure of choice for the repair of the most extensive perineal lesions.

OPERATIONS ON THE VULVA

For the excision of benign tumors of the labia majora and minora it is customary to use the field-block procedure, by which the tumor is circuminjected with the 0.5 per cent. solution from several points of entrance placed around it. Operations about the meatus of the urethra and those involving the anterior portion of the genitalia are best performed after anesthesia of the vulvar orifice, including the labia majora. Anesthesia is induced in the following manner: After performing the sacral block (page 285) by injecting 20 c.c. of the 1 per cent. solution in the sacral canal, and about 30 c.c. of the same solution in the posterior sacral foramina from S^1 to S^4, the patient is placed in the dorsosacral position and two wheals are raised, one on each side, over the pubic spines. Through these wheals a needle of convenient length, attached to the syringe filled with the 0.5 per cent. solution, is passed first in a direction perpendicular to the surface of the skin, then more

and more obliquely, distributing the solution in the subcutaneous tissue of the pubic eminence and genitofemoral fold lateral to the labia majora. From another point of entrance placed between the anus and vulvar orifice, subcutaneous injections are made in the direction of the arrows. The pubic injections are meant for blocking the nerves approaching the labia majora from the inguinal region; those from the preanal wheal

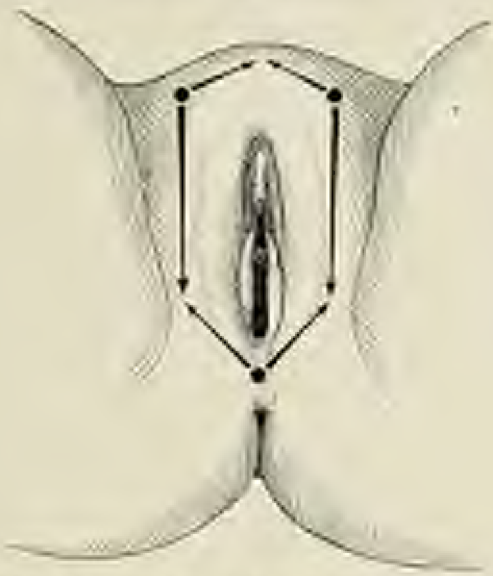

Fig. 301.—Field-block for operations on the vulva. The two upper dots are wheals raised at the level of the pubic spine; the lower, between the anus and the vulva. The arrows show the direction of the subcutaneous infiltration.

complete the anesthesia in case the pudendal branch of the small sciatic has been missed by the sacral injections.

CESAREAN SECTION

Cesarean section is most easily performed by means of local or regional anesthesia, especially when the pregnancy has reached its full term. The injection of the 0.5 per cent. solution along the line of incision is all that is necessary in the majority of cases. The idea of avoiding alteration in the vitality of the tissues to be approximated sometimes suggests the injection of two walls of anesthesia, one on each side of the linea alba, and parallel with it. The advantages of the

field-block procedure, by which the injections are made within the rectus sheath, are here considerably reduced, if not entirely destroyed, by the condition of distention of the abdominal wall, which naturally relaxes as soon as the uterus has been emptied, thus allowing easy approximation of the tissues. If two walls of anesthesia are established, one on each side of the linea alba, they are usually traced about 3 finger-breadths from the midline, and extend from the pubes to about 10 cm. above the umbilicus. The 0.5 per cent. solution is freely distributed in the abdominal wall, which, as a rule, is very thin. It is very difficult to be aware of the needle's progress through the different layers of the abdominal wall if the needle is introduced in a direction perpendicular to the surface of the skin, as is usually done in the course of any other abdominal field-block. Instead of making fanwise injections, subcutaneous and subfascial infiltration must be accomplished with the needle advancing in a direction parallel with the surface of the skin, the solution being distributed steadily and continuously while the needle is advanced as well as when it is withdrawn. There is no fear of passing the needle into the uterine cavity, even when injecting the uterus as proposed by Allen. The resistance offered by the uterus is such that the needle is always stopped as soon as the organ is reached, its peritoneal coat only being pierced. The injection of the outer surface of the uterus, besides, requires considerable pressure, which is the characteristic feature indicating that the needle has left the abdominal wall. If the anesthetic procedures are restricted to the abdominal wall, as recommended, the needle is restored to its correct position in the structures of that wall in order to avoid wasting the solution in the ordinarily insensitive uterine wall, leaving undisturbed the sensibility of the abdominal wall.

CHAPTER XI

OPERATIONS ON THE LOWER EXTREMITIES

The lower extremities derive their sensory innervation from the branches of the lumbar and sacral plexuses which approach the region at points scattered around the root of the thigh: the sciatic nerves emerge from the pelvis in the gluteal region; the external cutaneous and anterior crural nerves, beneath Poupart's ligament; the obturator nerve, through the obturator canal. The twelfth thoracic, iliohypogastric, ilio-inguinal, and genitocrural nerves also contribute to the nerve supply of the gluteal region and the root of the thigh.

Unlike the disposition of the nerves of the upper extremities, all uniting in a bundle which is accessible from a single point of entrance, the nerves of the lower extremities must be injected individually, and the difficulties encountered in reaching all of them with equal ease are rendered still more apparent by the simplicity with which the intraspinal block is accomplished. For this reason spinal anesthesia has hitherto been preferred to regional anesthesia for operations on the lower extremities.

Major operations on both extremities at the same session are not very frequent, and the use of spinal anesthesia is not imperative for the great majority of operations on only one limb. Except for disarticulation of the hip-joint, or high amputation of the thigh, regional anesthesia is very satisfactory and should always be preferred to other methods. Resections of the knee have many times been performed after blocking the nerve supply of the lower extremities at the root of the thigh. For operations on the leg and foot regional anesthesia is the method of choice. It is out of proportion to the operation to induce spinal anesthesia or administer general narcosis for a simple bunion operation (hallux valgus), or the correction of a hammer-toe, or even for the aseptic arthrotomy of the knee-joint, *a fortiori*, for disarticulation of a toe or other minor operations.

For operations involving the soft tissues of the gluteal region the operative field is blocked by circuminjecting walls of anesthesia at a little distance from the lesion, using the 0.5 per cent. solution; but, if the framework is involved in the operation, it will be necessary to apply the nerve-block procedure.

Fig. 302.—The sensory nerve supply of the lower extremities (half-diagrammatic).

The anesthesia of the entire lower limb may be realized by two procedures, viz., the paravertebral block of L^1 to S^3, or the blocking of the sciatic, external cutaneous, anterior crural, and obturator nerves at the root of the thigh. The difficulties encountered in obtaining perfect

anesthesia by these procedures suggest the use of the local or regional field-block, as described hereafter. Disarticulation of the hip-joint are best performed and high amputation of the thigh best made by means of spinal anesthesia induced in the fourth lumbar space.

REDUCTION OF DISLOCATION OF HIP-JOINT

A low spinal anesthesia meets every purpose, but if local anesthesia is resorted to, it is necessary to distribute the solution around the dis-

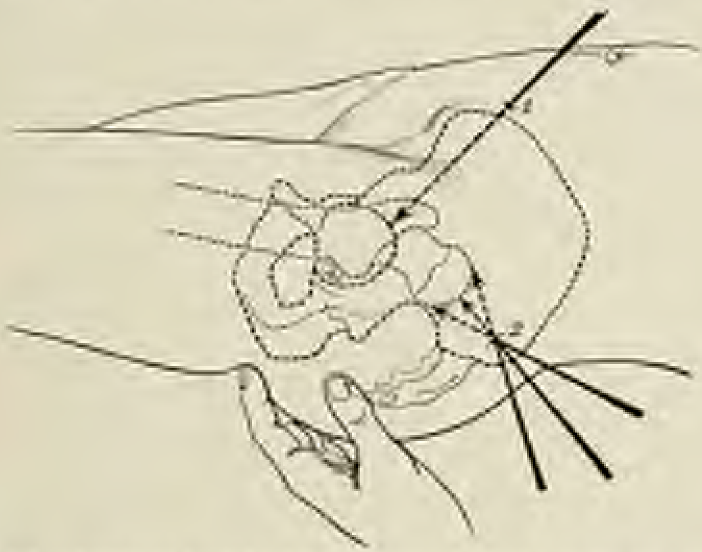

Fig. 303.—Anesthesia for reduction of posterior dislocation of the hip-joint. The acetabulum is injected from 1. The needle is inserted at 1 and advanced in the direction of the fingers placed on the tuberosity of the ischium. The head of the femur is reached from 2 in the gluteal region.

placed head of the femur and inject the joint cavity, whatever be the type of dislocation. Quénu was the first to apply this procedure; Braun and others have used it successfully. In the case of a posterior luxation, for instance, the head of the femur is defined by palpation, and a long needle (No. 5, 10 cm.) is introduced through a point in the gluteal region and advanced toward the displaced bone, around which about 20 c.c. of the 1 per cent. solution is distributed.

The joint cavity must now be injected. As Braun justly remarks, the dislocated head of the femur cannot be used as a landmark for

inserting the needle into the joint cavity, owing to its changed relative position to the cavity. It is, therefore, necessary to adopt a point of entrance which will suit all types of dislocation of the hip. The anterior superior iliac spine, acetabulum, and tuberosity of the ischium are on the same straight line. In the majority of cases it is possible to define both spine and tuberosity by palpation, so that the acetabulum may be injected from a point of entrance on, or just behind, the anterior superior iliac spine, while the needle is advanced toward the tuberosity of the ischium. The needle is passed in close contact with the iliac bone until it is felt passing over the margin of the cotyloid ligament into the joint cavity, where 20 c.c. of the same solution is deposited. The aspiration of the bloody synovial fluid and the intracapsular injection of the anesthetic fluid are shortly followed by relaxation of the joint. The limb becomes movable, greater facility being thus afforded for manipulating the displaced bone.

For anterior dislocations care should be exercised not to puncture the femoral vessels, the injections around the head of the femur being made from a point of entrance in the groin close to the displaced bone.

EXCISION OF FEMORAL LYMPH-NODES

Anesthesia is induced by blocking the external cutaneous nerve (page 246), anterior crural nerve (page 247), and obturator nerve (page 249), and distributing the solution beneath Poupart's ligament and subcutaneously along that ligament.

Field-block of Scarpa's triangle also gives very satisfactory results (Fig. 304). Needle No. 3 (8 cm.), unattached to the syringe, is introduced about 1 cm. lateral to the femoral artery, which is kept under the palpating finger to avoid its puncture, and the anterior crural nerve is blocked according to the technic previously described. The needle is then passed beneath Poupart's ligament, then subcutaneously along that ligament, distributing the solution from the anterior superior iliac spine to the pubic spine. From 30 to 40 c.c. of the 0.5 per cent. solution is necessary for the subcutaneous injections. The needle is next passed through the pubic wheal 3, and the obturator nerve is injected (page 249). Through a third site of puncture 3, placed at the

apex of Scarpa's triangle, subcutaneous injections are made along the sartorius and adductor longus muscles, up to Poupart's ligament, care

Fig. 304.—Field-block for excision of femoral lymph-nodes: 1, Anterior crural block and injection of Poupart's ligament; 2, obturator block; 3, subcutaneous injections along the sides of Scarpa's triangle.

being exercised to avoid the femoral vessels. These injections require about 40 c.c. of the 0.5 per cent. solution.

LIGATION OF THE FEMORAL ARTERY

For ligation in Scarpa's triangle the field-block procedure described for the excision of femoral lymph-nodes is satisfactory. If the artery is ligated in Hunter's canal it will be necessary to block the anterior crural nerve (page 247) and the obturator nerve (page 249) in order to obtain perfect anesthesia.

OPERATIONS FOR VARICOSE VEINS

The method of anesthesia depends on the operative technic adopted. For the Trendelenburg operation circuminjection is the procedure of choice. If only one ligation is performed at the level of Scarpa's triangle the field-block procedure described for the excision of femoral

lymph-nodes is sufficient. For the ligation or resection of the long saphenous vein at the three classical stages along the course of the vein it will be necessary to make supplementary injections of small areas at each of the lower levels. For this purpose subcutaneous injections are made along the sides of a rhombus, the greater diagonal of which lies along the line of incision. For extirpation of large varices several wheals are raised on both sides of the lesion and the solution distributed beneath the varices and subcutaneously along the lines joining the wheals together. The 0.5 per cent. solution is used in every case. The blocking of the external cutaneous nerve (page 246), anterior crural nerve (page 247), and obturator nerve (page 249) must be resorted to for the Mayo operation.

OPERATIONS FOR GENU VALGUM

Supracondylar osteotomy of the femur is performed painlessly by means of regional anesthesia. If the blocking of the nerves supply-

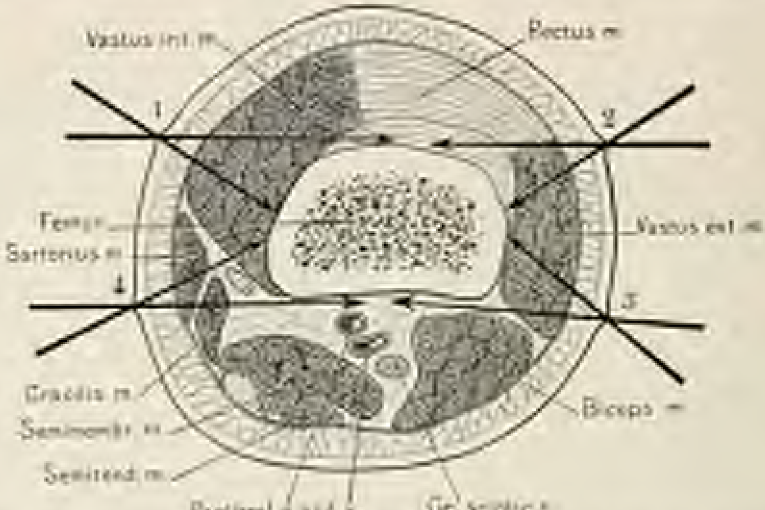

Fig. 395.—Cross-section of the thigh, showing the manner of injecting the femur for supracondylar osteotomy: 1 to 4 are the sites of puncture through which the needle is passed and advanced in the direction of the arrows.

ing the entire limb cannot be performed at the root of the thigh, or proves to be unsuccessful, the following procedure of local infiltration,

as suggested by Braun, may be easily accomplished by the average surgeon. It is used for unilateral as well as for bilateral operations. Four wheals are raised around the circumference of the thigh, as illustrated in Fig. 305. Through these wheals needle No. 3 (8 cm.), attached to the syringe filled with the 0.5 per cent. solution, is introduced and advanced toward the bone, where fanwise injections are made in the immediate neighborhood of the bone, along the plane passing at right angles to the axis of the femur. From 80 to 100 c.c. of the solution are used for these injections. Two other wheals are next raised at the extremities of the intended line of incision, and fanwise injections are made from the skin to the bone, involving all the tissues to be cut through.

RESECTION OF THE KNEE-JOINT

Anesthesia is induced by blocking the anterior crural nerve (page 247) and the sciatic nerves (page 289), and making subcutaneous and subfascial injections around the thigh, at a distance of about 5 cm. above the patella, using about 50 c.c. of the 0.5 per cent. solution for these injections. It is, however, preferable to induce spinal anesthesia between L^4 and L^5 for this operation.

SUTURE OF THE PATELLA

Anesthesia for the suture of a fractured patella is obtained by circuminjecting the anterior aspect of the knee and making an intra-articular injection with the 0.5 per cent. solution. Five wheals are raised, as illustrated in Fig. 306: the first, about 5 cm. above the patella; the four others, two on each side, on the medial and lateral aspects of the knee, beyond the limits of the intended line of incision. Needle No. 2 (5 cm.), connected with the syringe, is introduced through each of these wheals in succession and the solution distributed subcutaneously and subfascially in the soft structures surrounding the joint, the injections extending downward to about the level of the tubercle of the tibia. The joint is then filled with as much of the 0.5 per cent. solution as it will hold without causing too much distention. By gentle movements of flexion and extension of the leg the injected

fluid spreads over the surfaces of the joint and soaks the fractured segments of the patella. From 100 to 150 c.c. of the 0.5 per cent.

Fig. 506.—Field-block for suture of the patella: 1–2–3 and 1–2'–3', injection of the soft structures overlying the joint; C, intracapsular injection.

solution are necessary for the injections. The anesthesia sets in rapidly and the operation is painless.

ARTHROTOMY OF THE KNEE-JOINT

Aseptic arthrotomy of the knee-joint for loose cartilages and for meniscus operations are very easily performed by means of the following procedure: The joint is filled with from 20 to 30 c.c. of the 0.5 per cent. solution, and the soft structures overlying the articulation are infiltrated either along the line of incision or, better, in the manner

described for suture of the patella (page 429), which gives a wider zone of anesthesia. The 0.5 per cent. solution is used in both cases; the quantities injected vary with the technic adopted.

EXTIRPATION OF THE PREPATELLAR BURSA

Six wheals are raised around the bursa (Fig. 307). Needle No. 3 (8 cm.), connected with the syringe filled with the 0.5 per cent. solution,

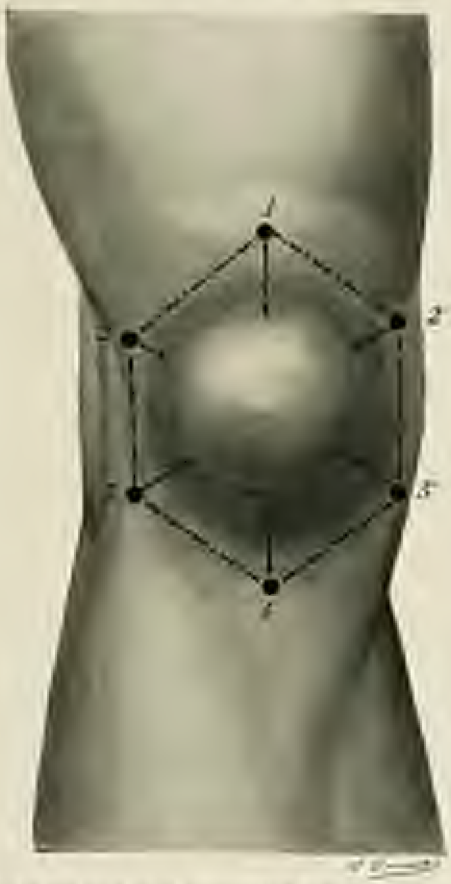

Fig. 307.—Field-block for extirpation of prepatellar bursa. The needle is passed through wheals 1 to 4 and advanced toward the patella in the direction of the arrows.

is introduced through each of these wheals in succession and advanced radially toward the margins of the patella, and the solution distributed around that bone, as proposed by Braun. Subcutaneous injections are

finally made along the lines, joining all the wheals together. If the size of the tumor does not allow the needle to reach the edges of the patella, the operative field is insensitized by the horseshoe infiltratian made in the manner described for suture of the patella (page 429). Local infiltration according to the first technic is not advised in a perforated bursa, especially when it is associated with a phlegmonous condition of the neighboring parts, the horseshoe block being the procedure of choice.

OPERATIONS ON THE LEG

For all operations on the leg, even if they are confined to the skin and superficial fascia, it is necessary to block the internal and external popliteal nerves at the popliteal space (page 291), and make a subcutaneous infiltration around the leg, just below the tubercle of the tibia. Reduction of fractures and amputations of the leg are thus painlessly accomplished without the use of general anesthesia.

OPERATIONS ON THE ANKLE AND FOOT

If the surgical maneuvers do not extend beyond the base of the malleoli it is sufficient to block both anterior and posterior tibial nerves as already described on pages 296 and 297, and make a ring of subcutaneous infiltration around the leg, passing through the sites of puncture of the same nerves, thus anesthetizing the whole foot and ankle. This procedure is the method of choice for all operations on the foot. Amputations according to the methods of Pirogoff, Chopart, Lisfranc, disarticulation of the ankle-joint, and operations for the correction of club-foot are very easily performed by this procedure.

OPERATIONS ON THE TOES

Anesthesia of the toes is realized in the same manner as for the fingers, according to the method of Oberst. As when injecting the hand, the needle must always be introduced through the dorsum of the foot and never through the sole, the left hand serving as a guide to prevent the needle from piercing the sole.

For disarticulation of the great toe or amputation of that toe with

its metatarsal bone, three wheals are raised; the first, on the dorsum of the foot over the proximal end of the first interosseous space; the second, in the first interdigital fold; and the third, opposite the first, on the medial margin of the foot. With the foot held by the left hand, needle No. 3 (8 cm.), attached to the syringe filled with the 0.5 per cent. solution, is introduced through the wheal placed at the proximal extremity of the interosseous space, passed perpendicularly to the surface of the skin, then more and more obliquely, and advanced through the interosseous structures until the point of the needle is felt beneath

Fig. 308.—Field-block for disarticulation of the great toe. The interosseous space is injected through 2 and 3. The inner margin of the foot and part of the sole from 1. The dotted lines indicate the subcutaneous injections. Same procedure for bunion.

the skin of the sole. The solution is thus distributed fanwise while the needle is advanced as well as when it is withdrawn. The needle is next introduced through the wheal placed in the interdigital fold, and other fanwise injections are made at the distal extremity of the interosseous space, the needle being also passed subcutaneously along the line joining the two wheals together. Through the third wheal placed on the margin of the foot, injections are made beneath the metatarsal bone and subcutaneously above it, in the direction of the first wheal. From 40 to 50 c.c. of the 0.5 per cent. solution are required to obtain

complete anesthesia. The tip of the toe must be insensitive before the operation is begun. A massage of the region hastens the diffusion of the injected fluid and the appearance of the anesthesia. It is the procedure of choice for bunion operations (hallux valgus).

For amputation of the second, the third, or the fourth toe, with its corresponding metatarsal, the interosseous spaces adjacent to the metatarsal bone to be amputated must be infiltrated according to the technic previously described for operations on the toes. Four wheals

Fig. 309.—Field-block for resection of the third toe with a portion of its metatarsal bone. The adjacent interosseous spaces are injected from 1, 3, 2, and 4; the injections are carried beneath the metatarsal in the direction of *A*. When applied to the second toe the procedure serves for correction of a hammer-toe.

raised, one at each extremity of the interosseous spaces, are the points of entrance of the needle, the solution being distributed fanwise in both spaces.

If two consecutive toes with their respective metatarsal bones are to be resected, the three interosseous spaces involved in the operation must be injected, always using the 0.5 per cent. solution in such quantities as would not produce too much pressure on the blood-vessels of the region. In every case the infiltrated area is massaged and the operation begun only when the tips of the toes have become absolutely insensitive.

The anesthesia of the entire foot induced in the manner described for operations on the ankle and foot is a better procedure for more extensive operations on the toes and metatarsal bones.

Correction of a Hammer-toe.—Anesthesia is induced in the same manner as for the resection of the second toe with its metatarsal bone. The two adjacent interosseous spaces are infiltrated with about 20 c.c.

Fig. 310.—Field-block for excision of ingrown toe-nail. Ring of subcutaneous infiltration around the base of the toe.

of the 0.5 per cent. solution and subcutaneous injections are made joining the wheals together.

Excision of Ingrown Toe-nail.—Through two or three wheals placed on the dorsum of the great toe, a ring of anesthesia is infiltrated around the root of the toe, using about 5 c.c. of the 1 per cent. solution. The edematous ring is massaged and the operation begun only when the tip of the toe has become absolutely insensitive.

CHAPTER XII

INTRASPINAL BLOCK

(Spinal Anesthesia)

SPINAL anesthesia was first suggested by Corning in 1885; but it is to Bier that credit must be given for endowing surgery with the method. In 1898 Bier started with cocain as an anesthetic agent, and obtained complete anesthesia of the lower half of the body, although in one patient the analgesia extended as high as the scalp; but the after-effects, chiefly giddiness, severe headache, vomiting, and syncope, were most disturbing. Being under the impression that these symptoms were due to loss of cerebrospinal fluid, Bier kept his patients in bed for a long time. This did not help to relieve the condition. So he dropped the method as being too dangerous, and decided to await the discovery of a less toxic drug. The method was, however, continued by Tuffier in France, despite considerable opposition and notwithstanding the fact that it had been practically given up in Germany.

In 1891 Giesel isolated tropacocain from the leaves of the Java coca plant. The alkaloid was synthetically prepared by Liebermann in 1892, and has since enjoyed great favor in Germany. Its toxicity is half that of cocain. It was only in 1904, when Fourneau discovered stovain, that spinal anesthesia was again brought before the profession. Novocain was introduced the same year by Einhorn. It was found much less toxic than any of the anesthetic agents known at the time. Its combination with adrenalin gave it a high practical value in the method of local anesthesia, for which it is still considered as the ideal anesthetic agent; but when injected within the dura it was said to be less active than the other drugs. After a few trials with novocain, the pioneers of spinal anesthesia went back to stovain. Some surgeons used tropacocain; the minority reinjected cocain in weaker doses of purer solutions. The ill-effects of the drugs employed and the occasional fatalities due to the

method form the subject matter of many reports. In the meanwhile careful experiments were conducted with novocain on the human being, and the clinical observations actually tend to show that novocain must be preferred to the other anesthetic agents for the induction of spinal anesthesia.

It is not the author's intention to discuss the reasons why novocainization is safer than the other methods of spinal anesthesia, nor to dwell upon the merits of any individual technic. When dealing with a method which, for so many years, has met with considerable opposition, especially on the part of those who had little or no experience of its principles, one should be cautioned against trying too many procedures and experimenting with various drugs. Fatalities are mostly due to lack of experience; their occurrence is always detrimental to the method. Let those surgeons who are familiar with one method stick to it, if they consider that the advantages derived from it are the best; but those who are anxious to use spinal anesthesia for the first time, or desirous of improving the technic they are actually using, will find in the following pages a handful of information gathered from personal experience.

METHOD

Definition.—Intraspinal block is an extensive regional nerve-block, consisting in the injection of an anesthetic solution in the subarachnoid space and resulting in what is commonly called spinal anesthesia. It differs from paravertebral block and caudal or epidural block, in that the solution is introduced within the dura, whereas in the other forms of block anesthesia it is distributed outside the dura mater. Two conditions are, therefore, absolutely necessary to produce spinal anesthesia: puncture of the dura mater and subarachnoid injection of an anesthetic agent.

Instrumentarium.—*Syringe.*—It is not necessary to use a special syringe for inducing spinal anesthesia. An ordinary 5 c.c. syringe of the Luer type is quite sufficient, provided it is air-tight and that its attachment to the needle does not leak. The plunger must slide easily in the barrel, so as to give an accurate knowledge of the pressure with which the fluid is injected and allow of an even dosage of that pressure

at any time during the injection. If the special regional anesthesia syringe is at hand, it can be used with advantage. The author uses no other.

Needles.—Two needles are required: a special one for the puncture, and any other for aspirating the anesthetic fluid into the syringe, provided it fits the syringe air-tight. The special puncture needle must fulfil the following conditions:

(*a*) It must be of medium gage (1.1 mm. thick), so as to avoid too rapid flow of the cerebrospinal fluid, limit the velocity of the intraspinal injection, and leave but an insignificant wound of the dura capable of immediate closure on withdrawing the needle.

Fig. 311.—Spinal puncture needles, used also for caudal or epidural block. One of the needles has its stylet partly out, showing the device by which the stylet is held in position after being introduced its full length. The protective shield is shown separately.

(*b*) It must be of medium length (80 mm.), so as to allow the hand to take a good support on the back of the patient, while the needle is held by its hub between the thumb and forefinger, and at the same time be long enough to be used in fat patients. Cases are exceptional where a longer needle is required.

(*c*) It must have a short bevel (1.5 mm. at most), so that, when the whole bevel has just passed the dura, the point of the needle does not come in contact with the cord, or the cauda equina, when making high lumbar punctures. Long bevels remain partly out of the subarachnoid space.

(*d*) Its point must be sharp in order to transmit to the fingers, with great accuracy, the impression of the nature of the tissues traversed by the needle in its progression toward the subarachnoid space.

(*e*) It must be rigid and flexible, a condition which facilitates the control of any lateral pressure out of its axis.

(*f*) It must be unbreakable, but should not bend too easily. Steel needles are damaged by rust and apt to break. Platinum needles are too soft and become crooked after a few punctures. Nickel needles are the best.

(*g*) It must be provided with a stylet that fits the lumen of the needle exactly and smoothly and is ground to bevel with the needle. A pin-lock at its hub keeps the stylet in its correct position.

Graduated Glass.—A graduated glass is necessary to collect the cerebrospinal fluid, so as to make sure of the quantity withdrawn. Graduation in cubic centimeters is more convenient, since all measurements relative to the method are here referred to in the metric system.

Fig. 312.—Special ampule containing one accurate dose of sterile neocain for intraspinal block.

Anesthetic Agent.—Novocain hydrochlorid is the anesthetic agent employed in connection with the technic described hereafter. Novocain is a German product. Salts of identical chemical formula are prepared in different countries under various names: procain, in America; syncain, scurocain, neocain, etc., in France. All of them are used with equal advantage, provided the particular brand selected is pure and sterile. The drug may be either in the anhydrous or crystalline form, provided it is put up in special ampules (Fig. 312) containing accurate doses of *10 centigrams* and *12 centigrams*. The bulb of the ampule has a capacity of from 2 to 3 c.c. The solution is made by filling the ampule with the patient's cerebrospinal fluid. No other solvent is used and nothing else added to the novocain. The 0.10 gm. ampules are used in the average patient, *i.e.*, in those whose weight does not

exceed 150 pounds; the 0.12 gm. ampules, in very fat patients. The dose injected represents *1 centigram* of novocain for each *15 pounds* of the body weight of the patient. The contents of an ampule may be reduced, according to individual cases, by simply flowing out part of the solution aspirated in the syringe.

Cardiac Stimulant.—The fall of blood-pressure being the principal drawback of the method, it is customary to inject, some time before or immediately after the spinal injection, a stimulant which controls to a certain extent the circulatory condition, and serves to check at the same time the deleterious effect of the drug itself or of any impurities it may accidentally contain. Good results are obtained with the following stimulant, put up in 2 c.c. ampules:

Caffein	0.25 gm.
Sparteïn sulphate	0.05 "
Sodium benzoate	0.10 "
Strychnin sulphate	0.001 "
Distilled water	q. s. 2 c.c.

The solution must be neutral. It is usually injected subcutaneously when used as a preventive and in the treatment of light symptoms, such as pallor of the face and cold sweat. It is injected in the subarachnoid space, in the case of total respiratory failure, before any attempt is made to restore breathing by artificial respiration.

Preparation of Patient.—A hypodermic injection of morphin ($\frac{1}{4}$ gr.) and scopolamin ($\frac{1}{200}$ gr.) is given one hour before the anesthesia is induced, except in very weak patients, and for operations on the lower extremities, unless it is absolutely necessary to eliminate the factors of apprehension and discomfort on the operating table. All prostatics do not need a preliminary injection of the combined narcotics: it is used only in the strong and nervous patient. The psychic condition of women is greatly benefited by its use, especially for gynecologic operations. For abdominal operations all patients are eligible for at least one dose of morphin and scopolamin, except those suffering from chronic conditions of the main organs, which make them very poor surgical risks.

Position of Patient.—The spinal puncture is made in the upright

position, with the patient sitting across the operating table, feet resting on a stool, back arched, and leaning a little frontward under the care of an assistant or a nurse. If the patient is unable to sit up, through weakness or local pathologic conditions, the puncture is made in the lateral recumbent position, with the patient lying on either side and back

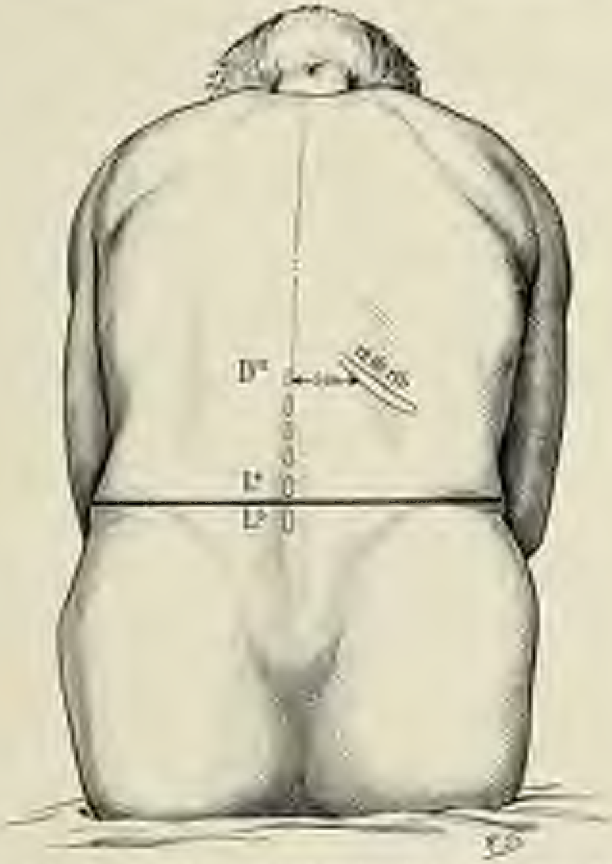

Fig. 312.—Position of patient and landmarks for intraspinal block.

arched. In this case he is turned over on his back immediately after the injection has been made, so as to allow of an even distribution of the anesthetic fluid on both sides of the cord.

Landmarks.—The usual landmarks are the iliac crests and the twelfth rib. The horizontal line tangent to the highest points of the iliac crests either crosses the spinous process of the fourth lumbar ver-

tebra or passes between the fourth and fifth lumbar spines. The perpendicular measuring 5 cm., dropped from the twelfth rib on the midline of the back, marks the spinous process of the twelfth dorsal vertebra.

Site of Puncture.—The site of puncture varies with the extent of the anesthesia required. For operations on the lower extremities, anus, perineum, external genitalia, and for perineal prostatectomy the injection is made between L^3 and L^4. For suprapubic prostatectomy, resection of the bladder, inguinoscrotal herniotomy, Kraske operation, vaginal hysterectomy, and operations for uterine prolapse and cystocele, between L^2 and L^3. For abdominal hysterectomy, between L^1 and L^2. For operations on the kidney and ureter, and all operations on the organs of the upper abdominal cavity, such as gastrectomy, cholecystectomy, splenectomy, etc., it is necessary to inject between D^{12} and L^1. The injection made at this level produces anesthesia extending as high as the line of the nipples. No attempt is made to produce a more extensive anesthesia.

TECHNIC

The syringe and needles are tested as to their efficiency. The needle used for aspirating the anesthetic solution is connected with the syringe, and the instruments thus ready for use are placed at hand.

The caffein compound stimulant is aspirated in a 2 c.c. Luer syringe provided with a hypodermic injection needle and also placed at hand ready for use.

The patient is next placed in the correct position for puncture and a wide rectangular aseptic field prepared, in the same manner as for any operation, extending vertically from the tenth dorsal spine to the sacrum and laterally to the tip of the twelfth rib on both sides. A sterile towel, with a suitable split in the middle, is opened on the field thus prepared. The landmarks are defined by palpation, and the site of puncture selected according to the extent of the anesthesia required.

In the meanwhile the neck of the ampule containing the anesthetic agent is filed off by an assistant and its opening flamed over a Bunsen burner or alcohol lamp, and is thus ready, immediately before the puncture is made. If the ampule has been kept in an antiseptic solution, it should be dipped in cold sterile water and wiped dry before

being filed. The same precaution should be taken with the file. In this case the neck of the ampule need not be flamed, but the assistant must be sterile.

The patient, who has already been informed of the method of anesthesia to be used in his case, is now warned that an injection will be made in his back and that he should not move until he is told to do so.

The skin of the space to be punctured is fixed and stretched over the underlying structures between the thumb and forefinger of the left hand placed on each side of the midline; the wrist being turned

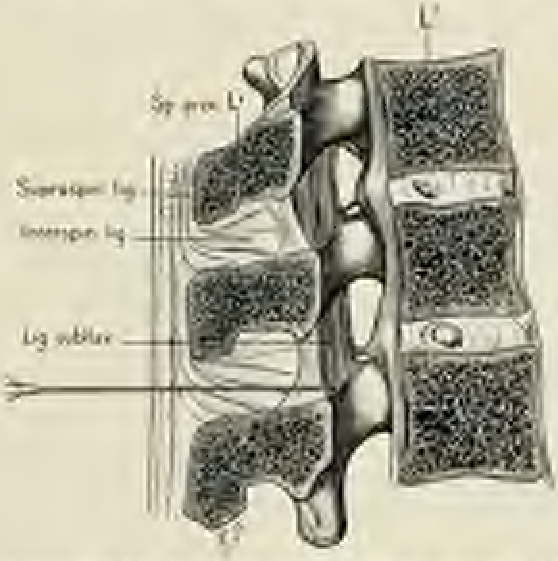

Fig. 314.—Sagittal section of the lumbar spine showing the direction of the needle which is perpendicular to the surface of the skin.

toward the sacrum, when the patient is in the upright position, or in the right lateral recumbent position; toward the head, if he is lying on his left side. With the skin thus fixed and stretched over the selected lumbar space, the spinal puncture needle, with its stylet fully in and in its correct position, is firmly held by its hub between the thumb and forefinger of the right hand, and its point placed on the midline, half-way between the spinous processes limiting that space. The needle is then inserted perpendicularly through the skin by a sudden and quick thrust. Sometimes the needle is passed through a small

wheal raised at the selected site of puncture. When the point of the needle has passed the skin, its position should be verified before it is advanced in the deeper structures. With the wrist of the right hand firmly held against the back of the patient, or the operator's left hand, the needle is advanced gently and gradually perpendicularly to the surface of the skin, along the median plane of the body, until the subarachnoid space is reached. If the needle is introduced in the middle of the supraspinous ligament, very little pressure suffices to carry it without deviation through the structures overlying the dura. The

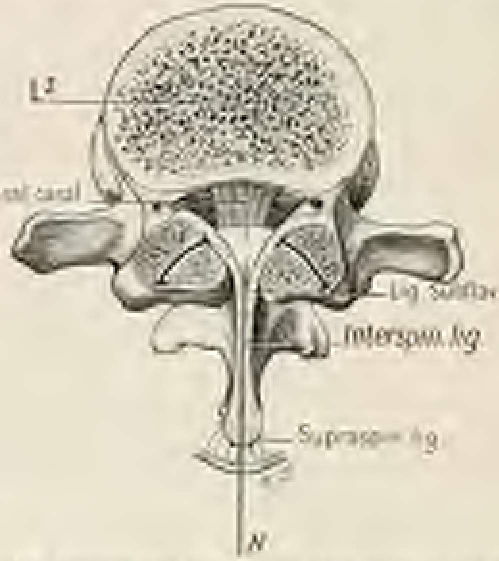

Fig. 315.—Cross-section between the second and third lumbar vertebræ, showing the needle (*N*) in its correct position for lumbar puncture.

interspinous ligament is the needle's best guide toward the intervertebral hiatus. The resistance of the interspinous ligament and ligamentum subflavum is soon lost and the point of the needle reaches the epidural space. The needle is now advanced, still more gently and gradually, until the dura is pierced, 1 or 2 mm. deeper. The rupture of the dura ordinarily transmits to the fingers an impression which cannot be more naturally compared than to the snap through a stretched membrane. As soon as the dura has been pierced, the needle is stopped and its stylet gently withdrawn, care being exercised not to

displace the needle even slightly. The first few drops of cerebrospinal fluid which flow out are allowed to fall in the graduated glass used to measure the quantity of fluid withdrawn. The ampule containing the novocain is then filled almost to its neck with the cerebrospinal fluid obtained directly from the needle, and, after gently stirring, the solution thus extemporaneously prepared is aspirated in the syringe. During that time from 10 to 25 c.c. of spinal fluid have been withdrawn, according to the needs of the particular case (see below). After expelling all the air contained in the syringe the needle used to aspirate the solution is detached from it, care being exercised not to disturb the position of the plunger. The syringe is next gently connected with the spinal needle, while this is held firmly by its hub, so as to prevent its displacement, even the slightest. As much new fluid is brought into the syringe as it now contains solution. Half of this is injected very slowly, more new fluid is aspirated, the syringe is discharged in the same way, leaving less and less fluid in it, and at the end of four or five injections it is emptied. The needle is then suddenly withdrawn, with the syringe still attached to it, and the patient asked to lie flat on his back. A cushion placed under his head allows him to rest and breathe more comfortably. The position resulting from this slight flexion of the head has probably a favorable influence on the blood-supply of the brain, while the effect of the anesthesia on the general circulation gradually develops. Injection of the cardiac stimulant is now made. The anesthesia sets in very rapidly. By the time the operative field is prepared the anesthesia is perfect. Its duration varies from forty-five minutes to one and one-half hours, but *one hour is the average time available for operation.*

Quantity of Fluid Withdrawn.—The quantity of fluid withdrawn varies directly with the intraspinal pressure, which is itself proportional to the blood-pressure. If a needle of the same moderate gage is always used, the manner in which the cerebrospinal fluid escapes gives an approximate idea of the intraspinal pressure. If the fluid spurts out like a stream, the pressure is high; but the flow soon weakens to rapid successive drops and finally to slow dripping, which corresponds to the time taken to withdraw from 20 to 25 c.c. of the fluid. If the pressure

is about normal, rapid successive drops are first noticed, the flow always weakening to slow dripping. From 10 to 15 c.c. of the fluid have by that time escaped, but the appearance of headache in both cases prompts the cessation of further withdrawal of fluid. The flow may also start by slow drops. This does not always mean low pressure, but may be due to a partial obliteration of the lumen of the needle by a flap of the dura. To make sure of the existing condition the needle is rotated 90 degrees, then 180 degrees; and if no change is noticed in the flow, it is advanced or withdrawn a trifle more. It is customary to withdraw not more than 10 c.c. if the pressure is low, provided always that the patient does not complain of headache, in which case the flow is immediately interrupted and the injection made. In a few cases it is impossible to have more than the quantity of fluid needed to dissolve the anesthetic agent, and the withdrawal of new fluid by aspirating with the syringe is also impossible. The injection must be made by discharging the contents of the syringe at one time. The anesthesia is not always good in such cases. As a rule the higher the puncture, the less the quantity of fluid withdrawn.

Failure to obtain cerebrospinal fluid after puncturing the dura at different levels is exceptional. It is said to be due to the so-called "dry spine." The dry spine is mentioned by Gerstenberg, Hein, Lusk, and others as a condition in which the arachnoid is adherent to the posterior surface of the cord at certain levels, thus obliterating the subarachnoid space at the sites of puncture. Cases have been published in which a general anesthetic was resorted to after failure to bring cerebrospinal fluid (W. S. Bainbridge). The author has not as yet met with a dry spine.

CARE OF PATIENT

As soon as the patient is placed on his back he is asked to take a few deep breaths and continue breathing naturally. He is also told that very shortly he will not be able to move his legs and that the lower half of his body will go to sleep; that this will last for a couple of hours, after which everything will return to normal; that he must not be anxious; there will be no pain, although he will likely feel the surgeon

working. If he feels a little sick, he must not complain nor try to vomit, but take a few deep breaths, which will rapidly improve the condition.

The patient can be placed in the Trendelenburg position as soon as the operation is begun, and stay there until sensibility returns, without prejudice to his respiratory function. The Trendelenburg position has a tendency to retard respiratory failure. The position of the patient must be changed gently and gradually, especially after the operation, when passing from the Trendelenburg to the horizontal position. Respiratory failure is of more frequent occurrence at that stage of the anesthesia.

An intelligent attendant sitting at the head of the patient carries on a regular conversation with him, not merely for the sake of diverting his attention to some other topic, as in the case of regional anesthesia, but to put his brain to active work. A few questions are set which require long answers, so that the patient talks more than the attendant. The respiratory centers are thus also kept at work. Every now and then the patient is asked to breathe deeply a few times, and to continue breathing naturally. Breathing through the mouth has a special advantage in abdominal and pelvic operations: it releases the pressure on the diaphragm and relaxes the abdominal wall. The application of cold, wet sponges, often renewed, on the lips, forehead, and neck is highly appreciated by the patient, and minimizes the tendency toward nausea and vomiting. If a nauseated condition sets in despite the cold sponges, the nostrils of the patient are closed by pressing between the thumb and index-finger, so as to compel him to breathe through the mouth. This ordinarily improves the condition.

Some patients, unprepared by a preliminary injection of morphin and scopolamin, become restless on the operating table. They should not be allowed to move their head about, since this is apt to increase the nausea or interfere with the respiration. If it is necessary to complete the operation with the aid of general narcosis, care must be exercised to give it gently and gradually, watching the respiration of the patient, especially when inhalation begins. Some patients hold their breath at that moment and faint.

The attitude of the surgeon and his assistants is the same as when operating with the other methods of regional anesthesia (page 8).

If operative conditions permit it is customary to give the patient a cup of hot black coffee after the operation, soon after he has been placed in bed. The coffee is taken gradually by teaspoonfuls. No special postanesthetic care is particularly required, but the patient must be watched during at least one hour, if the operation has been of very short duration, as in the case of prostatectomy, for instance. If the condition of the patient is not satisfactory (weak pulse, pallor of the face, cold sweat, labored breathing), injection of a cardiac stimulant is all that is necessary.

There is no established rule regarding the position of the patient in bed. He may lie in the position in which he feels more comfortable. It is not necessary to lower the head for hours, as is done after the administration of general anesthetics, except in cases of headache or when the blood-pressure continues to be very low, as shown by weak pulse and pallor of the face. All our patients greatly appreciate one or two pillows under the head and shoulders as soon as sensibility is restored.

AFTER-EFFECTS AND THEIR TREATMENT

The after-effects incidental to intraspinal block are apt to occur at periods more or less close to the time of injection. The immediate symptoms are the outward expression of a series of phenomena which are chiefly dependent on the sudden lowering of the blood-pressure, especially the maxima. The circulatory system seems to be incapable of a quick response to such a sudden change. The patient complains of sickness and sometimes vomits. Pallor of the face and cold sweats are occasionally present. Respiration sometimes becomes shallow and gradually decreases in frequency. Fortunately, the routine administration of caffein and strychnin immediately after the intraspinal injection of the anesthetic drug greatly contributes to keeping the blood-pressure about normal, thus preventing, or avoiding to a considerable extent, the development of these symptoms. If they do appear, they are light and transient, yielding by deep breathing and the application of cold wet sponges on the face and neck.

Nausea.—Under the best conditions nausea frequently occurs in the Trendelenburg position and in the course of operations on the organs of the upper abdominal cavity, especially the stomach. If not cared for and treated as soon as it is signaled by the patient, nausea is almost always followed by a few vomiting spells. The usual treatment is the application of cold wet sponges on the face and neck, and compelling the patient to breathe through the mouth, closing his nose if he holds his breath. Nausea and vomiting are not alarming, but the attendant condition of the patient is so troublesome in abdominal surgery that preventive measures must be employed by the attendant sitting at the head of the patient. It is best to apply the cold wet sponges immediately after the patient has been placed on his back, and make him take a few deep breaths at intervals of two or three minutes. In the course of operations on the stomach rough manipulation is likely to increase the number of vomiting spells and make the patient feel worse. In the Trendelenburg position the bowels have a tendency to collect in the upper abdominal cavity. The increased pressure on the diaphragm, due to heavy packing back of the bowels, besides being detrimental to good breathing, seems to increase the degree of sickness. Packing must, therefore, be light.

Respiratory Failure.—Less frequent with novocain than with the other anesthetic agents, respiratory failure seldom happens immediately after the intraspinal block. When it does, it is due to the injection of too strong a dose of the drug, or to poor technic, such as unreasonably keeping the patient too long in the upright position. Its treatment is the following: Immediate Trendelenburg position, subcutaneous injection of the cardiac stimulant, if it has not already been given, and artificial respiration by moderate and rhythmic pressure on the base of the thorax. If the face continues to be pale, if the pulse is rapid and weak, and the corneal reflex slow, the patient is quickly placed in the lateral decubitus, another lumbar puncture made, and a dose of the caffein compound stimulant injected intraspinally. The patient is turned on his back, replaced in the Trendelenburg position, and artificial respiration is started. The injection of caffein in the subarachnoid space has given, in the hands of Bloch and others, very good

results. The author has no personal experience with this treatment, but proposes to use it when opportunity offers itself.

Respiratory failure occurs more frequently at the end of an operation in the Trendelenbrug position, when the table is reverted to the horizontal position, especially if the change is rapid and the patient weak or old. The table must, therefore, be raised gradually. In a few instances the condition of the patient has been rather poor since the beginning of the operation. It has passed unperceived by the inexperienced attendant; and it is only at the end of the operation, when the condition grows worse by the change of position, that the attention of the surgeon is called to it. Trendelenburg position delays respiratory failure. If the patient is properly cared for in that position, his condition improves rapidly. Beware of patients who are silent and motionless during the operation. Make sure that there is nothing wrong with them. It constitutes half the treatment of after-effects.

Incontinence of Anal Sphincter.—It happens once in a while that the patient loses matter during the operation. This is most annoying in the course of pelvic operations, especially total abdominal hysterectomy, since the Trendelenburg position facilitates the flow of the feces through the vagina into the abdominal cavity. It is, therefore, advised not to give a cathartic the day before the operation nor an enema on that morning, and to pack the vagina in all cases in which the surgical prodecures are likely to involve the uterus. The incontinence is never persistent.

Headache.—The headache incidental to the inadequate withdrawal of cerebrospinal fluid is, in the great majority of cases, not persistent. It yields spontaneously soon after the patient has been placed in the supine position; but it may persist in those cases in which access to the subarachnoid space was difficult, requiring multiple punctures. It is sometimes noticed in cases where the spinal puncture has given issue to a bloody fluid. The condition of the intraspinal pressure is greatly responsible for it. True postanesthetic headache begins a few hours after the injection, or the day after, without any apparent cause. It is generally not very severe and yields after the administration of a few doses of aspirin, the patient being kept flat in bed, with an ice-bag on

his head. If the condition does not improve after six hours' treatment, a spinal puncture is made in the lateral recumbent position and from 15 to 25 c.c. of fluid withdrawn. The headache disappears almost immediately after, and it seldom happens that another puncture must be made the following day. Cases of persistent severe headache are rare when novocain is the anesthetic agent and cerebrospinal fluid the solvent used, provided the injection technic is executed scrupulously and the patient properly taken care of.

Vomiting.—Postoperative vomiting seldom occurs with a good technic. The vomiting spells noticed at the time of the operation do not persist. In exceptional cases they last from twenty-four to forty-eight hours. The nauseated condition present after the induction of anesthesia, and chiefly dependent on the blood-pressure, is exacerbated by long fasting or by the rapid drinking of too much coffee given after the operation. The empty stomach does not, besides, accommodate itself to the hot water served, as a rule, after the administration of general narcosis. Unless operative conditions do not permit, the patient must be allowed to choose the drink he cares for on reaching his bed. If he does not express the desire for any particular beverage, coffee and alcoholic drinks are the best. Vomiting after gastric operations is much less frequent than after the administration of a general anesthetic, especially ether. It is treated by lavage as usual.

Retention of urine occurs in a certain percentage of cases, but yields rapidly after a few catheterizations. Operations on the pelvic organs are more likely to be followed by retention, which may last several days. It is advisable to catheterize the patient before inducing spinal anesthesia.

Ocular Palsies.—Paralysis of the abducent nerve is occasionally noticed. It lasts but a few hours and needs no treatment.

Apart from the foregoing after-effects, the occasional rise of temperature the night of the operation needs only be mentioned. Trophic changes already present in the soft tissues of the sacrococcygeal region at the time of the operation may be unfavorably influenced by the anesthesia and lead to sloughing. A round air-cushion must be used, especially if the patient is old or very thin. Cases of postanesthetic

paraplegia reported in the literature are probably due to the development of conditions already existing at the time of the anesthesia. Stovain was the anesthetic agent employed.

En résumé, intraspinal novocainization is attended by a few after-effects which are chiefly dependent on the fall of the blood-pressure. This condition can be controlled by the injection of a cardiac stimulant made at the time of the intraspinal injection of the anesthetic drug. The symptoms presented by the patient are of a transient nature and call more for intelligent care than for actual treatment. Respiratory failure is an alarming symptom whose frequency and gravity are directly proportional to the dose of novocain injected, the height of the puncture, the weakness of the patient, and the inexperience of the operator and his assistants.

INDICATIONS

The indications of intraspinal block are based on the type of operation and kind of patient. Taking into consideration that field-block and paravertebral block are excellent procedures that can be accomplished without the slightest inconvenience, intraspinal block should be restricted to major operations on the abdominal and pelvic organs, and to those on the lower extremities that are not within the scope of the local and regional methods.

Abdominal Operations.—Acute conditions of the abdominal cavity are greatly benefited by its use, especially in very fat patients. In spastic obstruction, spinal anesthesia acts rather as a curative treatment than as a procedure to relieve pain during the operation. Operations on the organs of the upper abdominal cavity should be performed under spinal anesthesia if the patient is fat, or stout, with tense, rigid abdominal wall, since the bowels in such cases are likely to protrude as soon as the abdomen is opened, even if paravertebral block is induced. In lean people the consideration of individual cases depends much more on the type of the contemplated operation. The surgical possibilities of the abdominal field-block associated with splanchnic analgesia are broad enough; those of the paravertebral block, none the less. The lowered resistance of the patient and his decreased sensibility to pain are favorable conditions for the performance of major operations with

the minimum anesthesia. Gastrectomies have many times been completed without the aid of inhalation narcosis, the abdominal wall only having been anesthetized. Spinal anesthesia is, therefore, indicated for gastrectomy, cholecystectomy, and splenectomy in lean patients whenever the other regional procedures are expected to give unsatisfactory results. For gastro-enterostomy, gastrostomy, cholecystostomy, colostomy, as well as for all kinds of ventral and inguinal herniotomies, the field-block and paravertebral block are the procedures of choice. For bilateral inguinal herniotomy and repair in very fat patients, and for the radical cure of voluminous inguinoscrotal or sliding hernia of long standing, spinal anesthesia has a high practical value. It finds an unquestionable indication for colectomy (partial or total) and ileosigmoidostomy.

Pelvic Operations.—For abdominal hysterectomy, vaginal hysterectomy, ovariotomy, operations for ectopic pregnancy, resection of the bladder, suprapubic prostatectomy, perineal prostatectomy, intraspinal block and paravertebral block can be used with equal advantage: the former, in fat patients; the latter, in all other cases. For the posterior resection of the rectum and rectosigmoid sacral block is the procedure of choice; but spinal anesthesia should be preferred to ether narcosis for such operations if the operator has but little experience with sacral block.

Operations On the Lower Extremities.—Disarticulation of the hip-joint, high amputation of the thigh, and operations for osteomyelitis of the femur are best performed under spinal anesthesia; resection of the knee, when the necessary manipulations for inducing nerve-block at the root of the thigh are likely to be too painful for the patient. In rare instances intraspinal block may be given for amputation of the leg instead of the sciatic block. These are chiefly in very fat patients, or when the phlegmonous condition of the limb renders the other local and regional procedures more or less risky.

Finally, intraspinal block is indicated for all major operations below the diaphragm, provided the paravertebral and sacral methods cannot be accomplished with equal advantage both to the patient and the surgeon. It finds also an unquestionable indication in patients suffer-

ing from chronic conditions of the lungs, heart, liver and kidneys, and in very fat people who, as a rule, are bad subjects for inhalation anesthesia.

CONTRAINDICATIONS

The chief contraindication to intraspinal block is a very low blood-pressure, that is, below 100. Even then, if it is expected that the condition of the patient will not be benefited by the administration of any other form of anesthesia, spinal anesthesia can be induced, provided a subcutaneous injection of the caffein compound stimulant is made at the same time, repeating the dose if necessary. Patients in a state of shock or toxemia only need local infiltration with or without the association of a first-stage narcosis. It is self-evident that local pathologic conditions of the spine contraindicate the use of intraspinal block. Lumbar puncture is a dangerous procedure in patients with cerebellar tumors, *a fortiori*, intraspinal block.

ADVANTAGES

Intraspinal block realizes perfect anesthesia with complete muscular relaxation. It produces a negative abdominal pressure, a most precious condition for easy and efficient exploration of the entire abdominal cavity and manipulation of the diseased viscus. The bowels become flat and lose their tendency to crowd the operative field. The anemia resulting from the fall of blood-pressure adds another valuable element to the existing abdominal silence; but, in any case, hemostasis must be perfect.

With spinal anesthesia there is scarcely any postoperative nausea and vomiting, no gaseous distention, no real gastric disturbances, no motor restlessness, no lung and kidney complications, of so frequent occurrence following the use of general narcosis. There is consequently no strain on the abdominal wall and, therefore, no local pain. The sutures are thus left undisturbed. Normal diet may be restored earlier; as a rule, it is not interrupted if the nature of the operation permits. Convalescence is thus rendered shorter.

Spinal anesthesia simplifies abdominal surgery by establishing the

most favorable conditions for a clean operation and reducing to a minimum the operative and postoperative risks.

DISADVANTAGES

There is only one real disadvantage connected with intraspinal block: the anesthetic agent cannot be administered gradually until the stage of surgical anesthesia is reached. The full dose must be injected at one time.

Failure to obtain anesthesia happens once in a while. It may be due to an insufficient dose, part of the solution having escaped while the syringe was freed from air or when it was connected with the spinal needle. Leakage between the syringe and the needle reduces the dose injected. The injection of inert or deteriorated solutions is also the cause of many failures. Anesthesia is sometimes delayed, or does not extend to the desired level. All these incidents which are reckoned against spinal anesthesia can be avoided by observing scrupulously the principles of the method herein described.

Anesthesia is available for one hour only in the great majority of cases; so that an unexpected long operation must be completed by inhalation narcosis or local infiltration. In abdominal operations, however, if a regional abdominal field-block is induced before the spinal injection is made, the closure of the abdomen can be accomplished painlessly when the spinal anesthesia is worn off.

CHAPTER XIII

DISCUSSION ON SPINAL ANESTHESIA

Intraspinal Block is an Extensive Regional Nerve-block.—When an anesthetic solution is introduced in the subarachnoid space the anesthesia obtained is the result of the physicochemical action of the drug chiefly on the nerve roots before they leave the dura. The gray or noble substance of the cord is but slightly if at all influenced by the drug, owing to its protective white sheath which is composed of nerve-fibers and seems to be very little permeable. It cannot, therefore, be said that the anesthesia is due to a physiologic section of the cord, although the paralysis of the segment below the site of puncture may suggest such an opinion. The nerves are blocked within the dura just the same as when injections are made at any level on their way to the periphery, with the only difference that within the cord they are more sensitive, more penetrable than elsewhere, since they are free from connective-tissue sheaths (epineurium). Again, the sensory and motor roots, being apart from each other, the action of the drug is greater on the motor fibers than when injecting the mixed nerve-trunks, even by the endoneural method, outside the spine. Motor paralysis is the natural consequence of intraspinal block.

The anesthetic fluid acts like a dye. It impregnates the nerve tissues more deeply at its first point of contact. Whence the necessity for making the injection as slowly as possible, so as to keep the solution in the close vicinity of the site of puncture and allow the nerve structures to take up the greater part of the anesthetic fluid, leaving a dose too weak to produce anesthesia by diffusion higher up. This condition is best realized by using the cerebrospinal fluid of the patient as solvent of the anesthetic drug, puncturing with a needle of moderate gage, reducing to a certain extent the intraspinal pressure, and controlling the pressure with which the fluid is injected.

In 1916 Stephenu Horbatsky, of Bucharest, made the following experiments in connection with the study of the circulation of the cerebrospinal fluid: Four children, from nine months to eleven years of age, suffering from severe gastro-enteritis, or tuberculous meningitis, were given intraspinal injections of 1 c.c. of a 5 per cent. methylene-blue solution at periods varying from ten to forty-eight hours before death. The injections were made between L^2 and L^3. At the autopsy, on opening the spine, the following observations were made: The epidural space in the neighborhood of the puncture was slightly stained; so was the dura on both aspects, in 3 cases as high as the occipital foramen. In 1 case the dye reached only a distance of 15 cm. above the site of puncture. The roots of the nerves and cauda equina were intensely dyed as far as from 1.5 to 2 cm. beyond the intervertebral foramina. Below the spinal ganglion the coloration decreased in intensity. The cord was strongly stained on its surface. The intercostal as well as the lumbar nerves were found to be stained as far as from 4 to 6 cm. beyond their exit from the intervertebral foramina.

These findings only tend to show that methylene-blue has a greater affinity for the nerve roots and the white substance of the cord composed of nerve-fibers than for the gray substance of the cord and the dura, but they cannot serve except as a rough comparison of what takes place with the anesthetic solution. Moreover, the return of sensibility after a comparatively short period of anesthesia is an argument in favor of the inference that the anesthetic drug is destroyed locally, or gradually discharged into the general circulation as it is given up by the nerve tissues. This process differs greatly from what is observed with methylene-blue which is still present in the spine forty-eight hours after the injection of a comparatively small dose of the dye.

After withdrawing a certain quantity of cerebrospinal fluid the intraspinal pressure decreases, and since a constant relation generally exists between the cerebrospinal fluid pressure and the blood-pressure, the secretion and excretion of more fluid must take place in order to make up for the deficiency created by the withdrawal of such fluid. The normal circulation of the cerebrospinal fluid also helps the diffusion of the waste anesthetic solution in the direction of its natural

current toward the blood circulation, that is, toward the periphery. If the solution is simply deposited at the site of puncture, it will not ascend toward the head when using cerebrospinal fluid as the solvent of the novocain. Patients placed in the Trendelenburg position for one hour do not show anesthesia of the upper extremities, thus indicating that no solution, at least no active solution, reaches the emergence of the roots constituting the brachial plexus. In certain cases it is desired to extend the anesthesia above the line of the nipples, as realized by Le Filliâtre's special technic called "barbotage," or to attempt the induction of anesthesia confined to a particular segment of the body, as claimed by Jonnesco. Whatever be the technic adopted, intraspinal block is an extensive regional block, the resulting anesthesia being a physiologic section of the nerve roots before they leave the spinal canal as single trunks.

Position of Patient.—For the spinal puncture and intraspinal injection every experienced man feels that the upright position of the patient with the back arched is better than the lateral decubitus. In fact, it is easier and more convenient for the anesthetist, but it is not so favorable for all kinds of patients. The upright position establishes conditions of faintness which must not be mistaken for those preceding respiratory failure, occasionally associated with a rapid fall of blood-pressure. Faintness is sometimes present before the injection is made. The mere fact of puncturing the skin may bring about this condition. It must, therefore, be watched for with great care, so that it may not eventually be superimposed upon the possible after-effects due to the injection of the anesthetic drug. Any pallor of the face, vertigo, nausea, or cold sweat during the manipulations for inducing anesthesia prompts the immediate change of position from the upright to the lateral recumbent. If the puncture has been made, and the cerebrospinal fluid is being withdrawn, the needle may be left *in situ* while the patient is gently moved from one position to the other, *provided the spinal puncture needle is unbreakable*. If these symptoms appear at the beginning of the manipulations, the patient is placed in the supine position and kept there for a while until the condition is improved. The puncture can then be made in the lateral decubitus position. If they set in at the end of the injec-

tion, the contents of the syringe are discharged all at a time, but *always slowly*, the needle is quickly removed and the patient placed on his back. The subcutaneous injection of the cardiac stimulant is given immediately, and by the time the blood-pressure falls, if it does, the fainting condition of the patient has disappeared. The author has never seen a respiratory failure calling for artificial respiration immediately after the intraspinal injection of novocain when punctures were made below the twelfth dorsal vertebra. It must, however, be remembered that this mishap has occurred to a few men and has been reported. The upright position of the patient remains the position of choice, notwithstanding the foregoing remarks. There is no hurry in placing the patient in the supine position, but there is also no reason for keeping him in the erect position until the anesthesia sets in.

The position which the patient should have after the injection has been made has, for quite a long time, worried the sagacious minds of many partisans of the method of spinal anesthesia. Fluids of different specific gravities were adopted to answer the question of diffusion of the anesthetic fluid toward the head which, it was alleged, was the main cause of respiratory failure. The use of these solutions has a tendency to disappear, but it is interesting to note the circumstances attending their injection. Those who use light specific gravity fluids raise the pelvis, so that the diffusion may not take place toward the head. If heavy specific gravity fluids are injected, it is customary to keep the patient for a certain time in the erect position. He is then placed in the recumbent dorsal position, but the elevation of the shoulders and head seem to be a necessity. The question of position after the injection seems, therefore, to retain the attention of such partisans more than the injection technic itself.

Respiratory failure and all other symptoms associated with spinal anesthesia are not due to the diffusion of the injected fluid to the brain and to the deleterious effects of the drug on the respiratory centers, but to three causes. There may be others, but only three seem to be manifest, viz., the anemia of the brain due to the fall of blood-pressure; a reflex started from the solar plexus whose physiology is modified by the anesthetic drug; a change in the type of respiration. The injection

of heavy doses is obviously followed by toxic symptoms of a more severe nature, and it is only then that the cessation of respiration may probably be attributed to the passage of toxic doses into the general circulation and the direct action of the drug on the brain cells.

The anemia of the brain is less apparent in the horizontal decubitus than in the upright position of the patient. The Trendelenburg position retards respiratory failure by establishing favorable conditions for the hyperemia of the brain. It should be resorted to in case of pallor of the face associated or not with shallow breathing. The simple change of position very often improves the condition, and the face of the patient instantaneously takes a bright color. The reflex started from the solar plexus seems to be responsible more for nausea and vomiting than for respiratory failure. The change in the type of respiration may bring about both conditions, and this only happens when the anesthesia involves a great number of the intercostal muscles.

The position of the patient does not influence the condition of nausea and vomiting to any appreciable extent, although it is more frequent in the Trendelenburg position, and ceases at the end of the operation when the patient is brought back to the horizontal position, especially in pelvic operations. If the patient feels sick in the Trendelenburg position, it is not necessary to revert to the horizontal position. It is sufficient to make him breathe deeply, then naturally through the mouth, and place cold wet sponges on his neck, as already advised. Care should be exercised not to allow the patient to hold his breath at any time. The contraction of the diaphragm and abdominal muscles are thus avoided, and the efforts to vomit eliminated. The essential part taken by the contraction of these muscles which raises considerably the intra-abdominal pressure is well known, and in this connection Magendie's experiment on the dog whose stomach he had replaced by a bladder filled with water cannot find a better clinical comparison.

The anesthesia of the sympathetic contribution to the solar plexus, consequently to the inhibitive apparatus of the stomach, the absence of alteration in the motor function of that organ, the increase in the intrathoracic vacuum caused by the sudden contraction of the diaphragm, are conditions which are sufficient to determine the vomiting spells, so

matter what position is given to the patient. In the Trendelenburg position the weight of the abdominal organs on the diaphragm adds to its contraction and increases the intrathoracic vacuum, which is associated with a greater dilation of the esophagus. Helped by the contraction of the stomach, the cardia opens and gives passage to the contents of that organ. Vomiting is not dangerous to life when the patient is in the Trendelenburg position under spinal anesthesia, but it is associated with disturbances which are very disagreeable in the course of abdominal operations more particularly. For this reason it is of the highest importance to try to prevent them from setting in, using the only means at our disposal, viz., deep breathing and the application of cold wet sponges on the anterior aspect of the neck.

The position of the patient does not apparently interfere with the change in the type of respiration incidental to the anesthesia of the intercostal muscles, although the Trendelenburg position may, by the added load of the abdominal viscera on the diaphragm, be detrimental to good breathing and occasionally give rise to respiratory failure. If the patient is asked to breathe deeply for two or three minutes and continue breathing naturally, the change of type of respiration will not be a surprise to him, regardless of sex. When high anesthesia is contemplated, it is a good precaution to teach the patient the manner of taking the best advantage of all his respiratory muscles. His education is entrusted to the room nurse, who thus contributes to the welfare of the patient long before the anesthesia is induced.

Puncture of the Spine.—The difficulties encountered in obtaining accurate landmarks in very fat patients have been mentioned in connection with paravertebral lumbar block (page 241). The puncture of the spine in lean patients is not always easy, although the landmarks are so prominent that they seem to be an exciting invitation to the inexperienced man to thrust the needle anywhere between them.

In all the lumbar spaces the needle must be introduced and advanced in a direction perpendicular to the surface of the skin. It is inserted on the midline of the back and at equal distances between the spinous processes limiting the particular space to be punctured.

The dorsal arch of any lumbar vertebra presents an inverted V- or U-shaped opening at its lower margin, resulting from the lack of closure of the laminæ. A similar, but smaller space, left at the upper margin of the vertebra below it completes the intervertebral hiatus closed by the ligamentum subflavum through which the needle penetrates into the spinal canal. The hiatus is generally fairly wide between D^{12} and L^1, its dimensions increasing as the lower end of the spine is reached. Differences, however, are well marked, and the hiatus is occasionally so narrow that the point of the needle comes in contact with the bone at the point where it was expected to find a free space. In a few instances, especially in the upper portion of the lumbar spine, the hiatus is somewhat hidden behind the lower portion of the spinous process, and the needle must be directed a little upward so as to reach it. The hiatus may at times be highly situated and punctiform. Exceptionally, the hiatus is absent, the laminæ coming so close together that it is materially impossible to get in. In this case the puncture is made in the space just below or above it.

To make sure that the spinal canal is impermeable in the space first punctured the needle is advanced in a direction perpendicular to the surface of the skin, that is, along the line of intersection of the horizontal and median planes of the body passing through the site of puncture. After coming in contact with the bone, the needle is partially withdrawn so as to change its direction, and reintroduced along the median plane of the body in a direction slightly inclined upward, aiming at a point about 2 mm. above that at which the bone had been felt the first time. It frequently happens that in this attempt the needle finds its way through the hiatus and pierces the dura. If it does not, the same maneuver is repeated several times while the needle is directed more and more obliquely upward, until a free space is felt. It is customary to search for the hiatus in a downward direction also, keeping the needle along the median plane. It is exceptionally found below the site of puncture if this has been taken correctly. In case of failure, another space is punctured, using gentleness to avoid trauma.

If the bone is felt at the first puncture, care should be exercised to observe the depth which the needle reached, so as to step it in due

time at the correct depth while puncturing fanwise hunting for the hiatus. It often happens that the dura offers very little resistance to the point of the needle, which does not transmit to the fingers a clear notion of the exact moment at which the spinal canal is entered. In the case of high punctures the cord is thus likely to be damaged, the more so if the needle is advanced during the unexpected jerk of the patient who reacts violently as soon as the point of the needle touches the cord, or even one of the nerves of the cauda equina.

In the adult the cord stops at the level of the second lumbar vertebra in the great majority of cases. Punctures made between D^{12} and L^1 and L^1 and L^2 should be made cautiously, the needle being stopped as soon as the dura has been pierced. A little hemorrhage of one of the posterior blood-vessels of the cord has no immediate ill-effects, but may be the source of remote troubles due to a hematoma in the substance of the cord. Below the second lumbar vertebra one of the nerves of the cauda equina may be hurt if the needle is handled too roughly. Sensory and motor disturbances may be the consequence, manifesting themselves at periods more or less remote from the time of the intraspinal puncture.

If the dura is not reached at a depth of 5 cm. in stout patients it is preferable to withdraw the stylet and make sure that the point of the needle is still outside the spine. If the needle has reached the subarachnoid space, there will be a flow of cerebrospinal fluid, unless the lumen of the needle is obliterated by a flap of the dura overlying its bevel. If no fluid is obtained, the needle is rotated from 90 to 180 degrees, so as to free its bevel from the dural flap. If this little maneuver still gives no fluid, the stylet is gently replaced in the needle which is gradually and carefully advanced until the dura is pierced. The snap of the needle going through the dura is sometimes heard at a distance. It is advisable that the beginner should renew the foregoing maneuver several times, advancing the needle a trifle further, until the notion is obtained of the puncture of the dura. In the absence of tactile sense, the flow of cerebrospinal fluid indicates that the opening of the needle lies within the subarachnoid space. It occasionally happens that, notwithstanding the greatest precautions, the point of the needle

comes in contact with either the cord or one of the nerves of the cauda equina, which is signalled by a jerk of the patient. Let it be a reflex for the operator to pull back immediately, just enough to keep the lumen of the needle within the subarachnoid space. Be cautioned against withdrawing the needle too much, since it will have to be reintroduced, and the same difficulties may be encountered.

The presence of blood flowing out of the needle does not always mean the puncture of a blood-vessel contained in the subarachnoid space. If the needle is introduced a little sideways it may hit one of the extraspinal or intraspinal (epidural) columns of venous plexuses. If pushed in too roughly at levels where the nerves of the cauda equina can be avoided, owing to their scattered disposition along the lateral walls of the canal, the point of the needle may puncture the network of anterior intraspinal veins and give rise to serious hemorrhage, the more so if a trocar is used instead of our medium gage needle. Soft needles have a tendency to slip sideways on the laminæ if they are not inserted just on the midline in the supraspinous ligament, thus advancing toward the posterior extraspinal veins. Occasionally a little distortion of the spine may be the cause of such mishap. The puncture may likewise bring out blood if the ligamentum subflavum is pierced laterally in the vicinity of the internal plexuses. The presence of pure blood, without cerebrospinal fluid, prompts the withdrawal of the needle and its reintroduction in the correct direction. This blood does not come from the spine. Gentleness must always be used, since the posterior internal plexuses interposed between the membranes of the cord and the inner surface of the canal may, as a result of trauma, supply blood enough to cause compression of the cord. If the needle has been bent while attempting the puncture, it must be replaced by a new one, or thoroughly straightened before it is reintroduced.

From the foregoing it is easy for the reader to understand how delicate the puncture itself is, and that the problem of spinal anesthesia is not merely to introduce a needle through any one of the lumbar spaces, but to do it correctly and neatly so as to avoid accidents.

Site of Puncture. Injection. Extent of Anesthesia.—If the technic herein detailed is observed scrupulously, the extent of anesthesia varies

with the site of puncture. The solution is merely deposited at certain levels where the roots of the nerves supplying the operative field are supposed to be found. Attempts are made to confine the anesthesia to as small a territory as is compatible with the intended operation, reasonable margin being made for a wider operation. It is not necessary to secure anesthesia of the entire abdominal cavity for an amputation of the thigh. The injection is, therefore, carried out as low as possible. Since it is not desirable to extend the anesthesia to the upper extremities, as for a disarticulation of the shoulder-joint, for instance, the highest site of puncture used is between the twelfth dorsal and first lumbar spinous processes.

Le Filliâtre has shown that it is possible to obtain general anesthesia by puncturing in the lumbosacral space. He uses a very large needle, a trocar, and after withdrawing a rather large quantity of fluid (30 c.c.), makes an intraspinal mixture of the injected anesthetic agent and cerebrospinal fluid. The cocain solution is injected with great pressure and forced upward to reach the head. New fluid is again taken in the syringe and re-injected with force several times. A large gage needle is of course indispensable for carrying out this procedure, which he calls "barbotage." This method was very useful during the war, because it allowed greater facilities for the treatment of wounds lying in different parts of the body. The soldier with multiple wounds could be attended to by several surgeons at the same time. It finds little application in civil practice owing to the greater risk with which it is attended.

Jonnesco injects at various levels without spoliation of cerebrospinal fluid. His two lately adopted sites of puncture are the upper dorsal and dorsolumbar. He uses stovain and strychnin in doses varying with the site of puncture and age of the patient. His needle is thin, which means low-pressure injection. He claims that he can obtain a segmentary anesthesia of the trunk, leaving intact the adjacent upper and lower segments. This method has been tried by a few men with varying results. The patient's reaction to high punctures is too violent to permit of this procedure to take rank among the regional procedures. It should not be attempted by the beginner.

The extent of anesthesia varies with the gage of the needle when the site of puncture and pressure of injection remain constant. The extent of anesthesia is independent of the site of puncture when a large gage needle is employed; it then varies with the pressure of injection. The safety of intraspinal block depends on the height of puncture, the anesthetic agent, the pressure of injection, and, above all, the experience of the man who uses it.

CHAPTER XIV

GENERAL DISCUSSION ON THE VALUE OF REGIONAL ANESTHESIA

THE use of regional anesthesia in the different branches of surgery has brought out that the advantages derived from the method are unrivaled. The value of the method is, in most cases, referred to general anesthesia as a basis of comparison, and it is chiefly in general surgery that this mode of appreciation is most apparent. It could not be otherwise, considering that inhalation narcosis has been for a considerable length of time the exclusive means of relieving pain during surgical procedures, and that, owing to the nature, variety, and extent of the operations admitted in the department of general surgery, it was not expected that the local methods of anesthesia would ever find a place in major surgery.

In ophthalmology every bit of the surgeon's work is now accomplished with the greatest advantage to all concerned by means of a few injections. The practical value of the local and regional procedures is well established in otology, rhinology, and laryngology. The most important conquest of nerve-blocking is the department of dentistry, which has completely abandoned the use of general narcosis. In urology the caudal block has completely changed the aspect of cystoscopy and prostatectomy. In gynecology the sacral block, associated with the paravertebral block and the abdominal field-block, competes with the intraspinal block to supplant general anesthesia. In general surgery field-block, paravertebral block, splanchnic analgesia, sacral block, and intraspinal block, either alone or judiciously associated with one another, all tend to set in a claim against inhalation narcosis.

The scope of operations capable of being performed by means of regional anesthesia is dependent on many factors which can all be reduced to the simple expression: *experience of the surgeon*. The method of preparing patients to undergo the operation in a state of conscious-

ness plays a very important rôle in the achievement of end-results. The choice of solutions and their judicious use in individual cases is as important as the exact knowledge of the anesthetic procedure that befits the patient. To be able to estimate in terms of the actual resistance of a poor surgical risk the dose of novocain to be used in his case is as significant as to know how to induce the anesthesia. To be familiar with the possible after-effects, their prevention and treatment, means as much as to be acquainted with the existence of the method of regional anesthesia.

The idea of widening the field of application of local infiltration at the time when cocain was the sole local anesthetic agent known gave rise to many accidents; and, were it not for the discovery of less toxic drugs, especially novocain, the use of local anesthesia would still be restricted to a few patients whose general condition made them too poor risks for ether or chloroform, that is, to moribunds. The introduction of adrenalin as a powerful adjunct still widened the scope of operations permissible with local infiltration, and stimulated the development of nerve-blocking by which it is possible nowadays to undertake a tremendous amount of major work in general surgery and meet the requirements of every surgical act in most of the specialties. The use of morphin and scopolamin, as a preliminary measure, in establishing favorable conditions for the necessary manipulations for inducing anesthesia, introduces in the system a smooth gear which drives the patient silently and obediently through the so-called ordeal, thus affording to the surgeon the best opportunities for the accomplishment of delicate and elaborate procedures.

The too hurried desire of the profession to try a new method before inquiring into the ways and means of employing it with success has sometimes led to irremediable errors. The introduction of an anesthetic fluid in the human body is not always followed by anesthesia of the operative field, but the presence of certain quantities of known solutions in definite parts of the body never fails to produce anesthesia of the desired region. Certain procedures applicable to major surgery are fraught with great difficulty, and must be tried several times on the cadaver before being attempted on the patient. The regional

technic for major operations must be learned on the living being under the supervision of an experienced man. Practice in minor surgery is very instructive, and helps to acquire experience for the injection of patients for major operations. Easy procedures afford better chances of success and should be tried first. The successful application of regional anesthesia to minor surgery contributes efficiently to home education, and consequently to the wide-spread use of the method. Demands often come from the patients themselves to have the operation performed under local anesthesia.

The too freely accepted proposition that the toxicity of novocain is negligible is deceitful. So long as local infiltration was restricted to minor operations, the injection of small quantities of the weakest solution (0.5 per cent.) necessary to produce anesthesia kept the method considerably within the limits of safety. Many men who had used it a few times did not fail to recommend it for the worst cases, and it soon became known to all the profession that novocain is almost devoid of toxicity. Anxious to extend the application of the method to major surgery, and to inject not only the weak but the vigorous patient as well, using the method as a substitute for general anesthesia, it was soon found that the quantities of solution required to produce adequate anesthesia for certain major operations contained heavy doses of the anesthetic drug which were still considered safe. Reports came from a number of authorized quarters that series of major operations had been successfully performed by means of regional anesthesia with only a weak percentage of after-effects of transient nature. No death had been registered in certain clinics. From other sources came the report of many disturbances due to the application of certain types of procedures, such as the brachial plexus block, the paravertebral block, and the caudal block. In a few instances fatalities had occurred which were attributed either to the poor condition of the patient preceding the anesthesia, or to the use of one particular procedure which seemed to be less safe than the others.

In widening the scope of regional anesthesia realized by means of nerve-blocking it was necessary to raise the concentration of the usual solution from 0.5 to 1 and 2 per cent., and even 4 per cent. Insufficient

warning was given of the disproportion existing between the rise in concentration and increase in toxicity of the anesthetic fluid. The announcement had already diffused to the remotest corners of the surgical world that novocain was many times less toxic than cocain, that its toxicity was negligible, and that it could be safely injected. The problem of local and regional anesthesia seemed to have been solved by the mere fact of being able to inject as much as 1 pint of the 0.5 per cent. solution, it was presumed, without the slightest apprehension. Lack of experience would very often have resulted in serious troubles had it not been the nature of the operation which required the injection of quantities of solution much below the lethal dose. The logical inference from what was thought of the 0.5 per cent. solution was that it was absolutely safe to use ½ pint of the 1 per cent. solution, which is, *clinically, absolutely dangerous.*

A marked distinction must be established between local infiltration and regional block. The injection technic in each case is the natural regulator of the toxic dose. If the solution is distributed in the structures of the body to be cut through, or excised, the local method admits of the use of enormous quantities of the weakest solution (0.5 per cent.), because the greater part of the injected fluid escapes almost immediately after the incision is made; but when the anesthetic drug is deposited at a distance from the operative field, as is always the case with the regional method, the total quantity injected passes through the circulatory system, a great part of it being distributed to the main organs of the body on which life is entirely dependent. The greater the dose injected in a unit of time, the more rapid the absorption and the heavier the dose presented to these organs in the same unit of time. The toxicity of the solution varies, therefore, with the velocity of injection, the concentration of the solution being constant. In certain regions of the body absorption is more rapid than in others; for instance, in the sacral canal and on each side of the vertebral column. Surgeons must have these facts present in their mind. If they do not inject their own cases, they must be cautioned against urging the anesthetist to inject the patient quickly. The judicious use of the anesthetic solutions is as important as an accurate knowledge of the injection technic. In-

jection of doses prescribed for a particular procedure may overtax the circulatory condition of the patient whose vital resistance has been lowered by previous diseases. In other instances the fear of administering the quantities of fluid necessitated by the extent of the proposed operation leads the inexperienced man to doubtful results, not to say complete failures. The quantities of fluid injected must be proportional to the needs of the particular procedure; its strength based not only on the resistance of the patient, but on the type of the anesthetic procedure which will best meet the requirements of the intended operation. For example: It is known that the injection of a 0.5 per cent. solution into the sacral canal does not influence the conductivity of the sacral nerves for surgical purposes. It is, therefore, useless to try to use it simply because the patient is a very poor surgical risk and is not likely to stand a 2 per cent. solution. The selection of another procedure is more rational. In certain cases the caudal block will be replaced by the transsacral block which requires a less concentrated fluid; in others, the association of the abdominal field-block with a few whiffs of ether or gas, or analgesia, will answer the question of operative risk more satisfactorily than the exclusive use of the regional procedure, just as it is prescribed for strong, robust adults.

The quantity of novocain solution prescribed for each particular procedure is an average dose under ordinary circumstances. The consideration of individual cases requires experience on the part of the surgeon who adopts the regional method with a view to reducing the operative risk to a minimum. The development of the method of nerve-blocking in major surgery is not based on its value in exceptionally poor cases, but on its practical importance as a method of anesthesia applicable, like inhalation narcosis, to all categories of patients, with the added advantage of befitting those in whom the administration of inhalation narcosis would possibly be dangerous to life.

There is no branch of surgery where the lack of experience of the surgeon and anesthetist is more likely to reduce the value of regional anesthesia than in general surgery. The nature of the operations, their variety and extent, the difficulties encountered in the execution of certain procedures, the greater demands for major operations

imposed on the method, the necessity for the use of refined surgical technic, all tend to overtax the knowledge and ability of the average man. It is even necessary for the expert to keep on practising daily so as to improve his technic and increase his experience.

The use of regional anesthesia as a substitute for general narcosis, whenever possible, is the only way of developing the method and acquiring experience. The injection of weak patients performed once in a while is far from being sufficient to train a man in the art of regional anesthesia; that is, to offer him the opportunities of mastering the difficulties of technic for the injection of individual cases. The occasional reaction of a strong patient to overdosage is a profitable lesson which the operator is glad to recall to his memory when asked to use the same procedure in poor surgical risks.

The foregoing discussion is not meant to discourage the profession, but serves to prove that the general opinion is erroneous which considers the practice of regional anesthesia to mean simply the accomplishment of a few injections, or the administration of a few ounces of anesthetic solution to a patient who cannot take ether. It shows how important it is to practice on all categories of patients and to use the method as a routine procedure. Of course, the regional anesthetist can inject only those patients who are selected and given him, when the surgeon does not inject his own cases, but surgeons should be more generous in charity hospitals, where considerable material is offered for teaching purposes, since the method is absolutely safe when the correct technic is observed. How can the profession estimate the value of the method if no effort is made to promote its study and wide-spread use?

DIFFERENT REGIONS OF THE BODY

The value of regional anesthesia is not the same in all parts of the body. It varies with the anesthetic procedure as well as with the surgical technic adopted. Confining the discussion to the field of general surgery, it can be said without risk of being contradicted that all operations on the scalp and cranium are within the scope of regional anesthesia. Sutures of the scalp and craniectomies are easily accomplished, although the manipulations on the cranium are not accepted

by all patients with equal indifference. In the majority of cases the preliminary hypodermic injection of morphin and scopolamin helps a great deal. The patient must have been told that there will be some knocking in the head, but no pain. Sharp instruments must be used and undue hammering avoided.

The resection of the posterior root of the trigeminus can be performed without the aid of general anesthesia; but the technic for the injection of the gasserian ganglion is so delicate, and requires so much practice before it is given successfully, that it will be some time before regional anesthesia is adopted for that operation.

For operations on the face and the organs contained in its cavities regional anesthesia is of the highest value for the following among other reasons: (1) It does away with the apparatus which for the administration of inhalation narcosis, crowds the operative field and sometimes interferes with the aseptic condition of that field; (2) it affords greater facilities for operations on the air-passages; (3) it eliminates the possibility of lung complications due to the aspiration of blood and septic contents of the oral and nasal cavities.

The anterior and lateral parts of the neck are easily anesthetized. The injection of its posterior aspect is fraught with great difficulties, especially in diffused pathologic conditions.

For operations on the thorax the quality of the anesthesia depends on the experience of the anesthetist. It is rather easy to obtain a very good anesthesia for laminectomy, thoracotomy and thoracoplasty, and simple amputation of the breast; the induction of anesthesia for total excision of the carcinomatous breast is more difficult.

The induction of anesthesia for abdominal operations is very difficult and requires long practice. Intraspinal block is more easily and quickly accomplished, and gives a greater percentage of good anesthesias than the paravertebral block or the splanchnic analgesia. As a rule, the injection of lean patients is always easier than the rest. The majority of patients of average weight can be anesthetized with success. Fat patients do not lend themselves with great facility and are better subjects for intraspinal anesthesia, unless the nature of the operation places them in the category of the ordinary patient; for instance, in

the case of a ventral hernia. The abdominal field-block for gastrostomy, gastro-enterostomy, hernias of all kinds, and suprapubic cystostomy is always successfully accomplished even in fat patients; that for appendectomy is not so satisfactory, except when combined with a few whiffs of ether or gas. Paravertebral block is good in every case, but it requires practice to be given successfully.

The anus, perineum, rectum, and prostate constitute one of the most fertile fields conquered by the sacral block.

The anesthesia of the upper extremities is relatively easy, that of the lower extremities difficult as a whole. For amputation of the thigh and resection of the knee the anesthesia is best realized by the intraspinal block. The lower extremities, however, lend themselves fairly well to the anesthetic procedures recommended for all other operations.

En résumé, although regional anesthesia is not of the same value in all parts of the body, its application to all regions cannot be denied, and likewise its practical usefulness as a substitute for general anesthesia.

ADVANTAGES OF REGIONAL ANESTHESIA

Regional anesthesia possesses decided advantages over general narcosis. It is not dangerous to life. Intraspinal block seems to be associated with some risk, owing to the rapid fall of blood-pressure which it produces, but this risk is considerably lessened with the improved and simplified technic herein described. Regional anesthesia realizes complete muscular relaxation, thus affording greater facility for the use of retractors and the accomplishment of delicate surgical procedures. It is in abdominal surgery that this condition is most apparent and best appreciated, its characteristic feature being a negative intra-abdominal pressure. The main effects of regional anesthesia are limited to a relatively small region of the body, leaving intact the central nervous system, upon the integrity of which depends the continuance of all the vital functions of the economy. The interruption of the sensory nerve conductivity realized by the anesthetic drug protects the brain from the effects of local operative injury; the combined narcotics, administered one hour before the operation is begun, reduce

to a minimum the psychic stimulation of the brain cells. Operative shock is thus considerably lessened if not entirely eliminated.

The general condition of the patient is not affected by any of these procedures; surgical convalescence is rendered shorter than after the administration of general anesthesia. It must be emphasized that regional anesthesia is not meant to improve chronic conditions which are present at the time of the operation, nor to prevent the development of acute disease started just before the operation. Regional anesthesia does not increase the resistance of the patient, but it reduces to a minimum the operative prognosis by not affecting the vital functions of the main organs of the body. Regional anesthesia does not prevent pulmonary embolism, but it dismisses the opportunity for pulmonary complications, since it does not interfere with the respiratory organs. Edema of the lungs, pulmonary congestion, or pneumonia will not set in as a postoperative complication if the usual elementary precautions are taken. Since regional anesthesia does not affect the gastro-intestinal tract, there is no postoperative nausea and vomiting, no acute distention of the bowels with consequent paresis, no strain on the abdominal cavity and its contents immediately after the operation. Normal diet is, as a rule, not interrupted if the nature of the operation permits; but if it has been necessary to interrupt it, it is restored earlier for the benefit of the patient.

Regional anesthesia is of the greatest advantage to the country surgeon who, being far from large surgical centers, cannot secure the services of a trained ether or gas anesthetist.

Postoperative pain is not more severe after regional anesthesia than after inhalation narcosis; but the absence of distress due to nausea and vomiting, which usually follows general anesthesia, gives the patient a clearer notion of his actual condition. His attention is thus more freely attracted to the region operated upon. The expression of postoperative pain varies with the patient and also with the anesthetic procedure employed. Some patients understand that they have just undergone an operation, and that there must be some pain and tenderness of the region when sensibility becomes normal. Others are surprised to see how little it hurts. After certain operations performed by means of the sacral

block, hemorrhoidectomy for instance, most patients do not complain of the effects of the trauma. Regional anesthesia seems to lessen postoperative pain until the return of sensibility, even in the case of such a traumatizing operation as the posterior resection of the rectum. The discomfort due to position or to faulty technic during the operation may continue in bed and add itself to the local postoperative pain, thus giving the impression that the postoperative pain itself is very severe.

INDICATIONS

The use of the field-block and nerve-block procedures is imperative in minor surgery, and for all operations where the general condition of the patient, the nature of the disease, and the region of the lesion contraindicate the administration of inhalation narcosis; more particularly in chronic conditions of the kidneys, lungs, heart, and blood-vessels, in septicemia, shock, hemorrhage, anemia, diabetes, obstructive jaundice.

Regional anesthesia is indicated as a substitute for general anesthesia for all operations on the anterior and lateral regions of the neck, particularly in goiter cases, tracheotomy, thyrotomy, and total laryngectomy; for operations on the organs of the upper abdominal cavity, and for the repair of all kinds of hernias. It is the method of choice for operations on the genito-urinary organs, the perineum, anus, and rectum. It is specially recommended for operations on the upper extremities on account of its simplicity.

Intraspinal block (spinal anesthesia) is indicated in all operations below the diaphragm, when the other procedures of regional anesthesia cannot be induced successfully, or are likely to fail. It is thus the procedure of choice in fat patients.

CONCLUSIONS

The practice of regional anesthesia is an art. It requires special knowledge of anatomy, skill in the performance of its various procedures, experience in the method of handling patients, and gentleness in the execution of surgical procedures.

Training on the skeleton and cadaver leads to a thorough knowledge of the anatomy required for the injection of patients. Practice

on all categories of patients affords opportunities for acquiring experience. The injection of easy cases leads to skill in major surgery. Novocain is the anesthetic drug of choice for all the regional procedures, including intraspinal block.

Again, the beginner is not expected to be successful with his first attempts; partial failures can be remedied by a first-stage, or a short period, of inhalation narcosis. There is no shame whatsoever to have recourse to the combined method, even though the operation was expected to be performed by means of regional anesthesia exclusively. The judicious use of a mixed anesthesia is always preferable to inhalation narcosis alone. We should not abandon the method as being insufficient and worthless; but, remembering that even experts may fail, we should try often and again, observing scrupulously its principles until we succeed.

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